MONTHLY WEATHER REVIEW.

Editor: Prof. Cleveland Abbe. Assistant Editor: Frank Owen Stetson.

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INTRODUCTION.

The Monthly Weather Review for April, 1905, is based on data from about 3583 stations, classified as follows:

Weather Bureau stations, regular, telegraph, and mail, 176; West Indian Service, cable and mail, 4; River and Flood Service, regular 52, special river and rainfall, 363, special rainfall only, 98; cooperative observers, domestic and foreign, 2565; total Weather Bureau Service, 3258; Canadian Meteorological Service, by telegraph and mail, 33; Meteorological Service of the Azores, by cable, 2; Meteorological Office, London, by cable, 8; Mexican Telegraph Company, by cable, 3; Army Post Hospital reports, 18; United States Life-Saving Service, 9; Southern Pacific Company, 96; Hawaiian Meteorological Service, 1; Jamaica Weather Service, 130; Costa Rican Meteorological Service, 25. Total, 3583.

Special acknowledgment is made of the hearty cooperation of Prof. R. F. Stupart, Director of the Meteorological Service of the Dominion of Canada; Señor Manuel E. Pastrana, Director of the Central Meteorological and Magnetic Observatory of Mexico; Camilo A. Gonzales, Director-General of Mexican Telegraphs; Capt. S. I. Kimball, Superintendent of the United States Life-Saving Service; Lieut. Commander H. M. Hodges, Hydrographer, United States Navy; H. Pittier, Director of the Physico-Geographic Institute, San José, Costa Rica; Commandant Francisco S. Chaves, Director of the Meteorological Service of the Azores, Ponta Delgada, St. Michaels, Azores; W. N. Shaw, Esq., Secretary, Meteorological Office, London; H. H. Cousins, Chemist, in charge of the Jamaica Weather Office; and Señor Enrique A. Del Monte, Director of the Meteorological Service of the Republic of Cuba.

Attention is called to the fact that at regular Weather Bureau stations all data intended for the Central Office at Washington are recorded on seventy-fifth meridian or eastern standard time, except that hourly records of wind velocity and direction, temperature, and sunshine are entered on the respective local standards of time. As far as practicable, only the seventy-fifth meridian standard of time, which is exactly five hours behind Greenwich time, is used in the text of the Review. The standards used by the public in the United States and Canada and by the cooperative observers are believed to conform generally to the modern international system of standard meridians, one hour apart, beginning with Greenwich. The Hawaiian standard meridian is 157° 30′, or $10^h\ 30^m$ west of Greenwich. The Costa Rican standard meridian is that of San José, $5^h\ 36^m$ west of Greenwich.

Barometric pressures, whether "station pressures" or "sea-level pressures," are now reduced to standard gravity, so that they express pressure in a standard system of absolute measures.

Since December, 1904, the Weather Bureau has received an average of about 1700 reports from as many observers and vessels, giving international simultaneous ovservations over the Atlantic and Pacific oceans at 12 noon, Greenwich time, or 7 a. m., seventy-fifth meridian time. These are charted, and, with the corresponding land observations, will form the framework for daily weather charts of the globe.

In conformity with Instructions No. 43, March 29, 1905, the designation "voluntary", as applied to the class of observers performing services under the direction of the Weather Bureau without a stated compensation in money, is hereby discontinued, and the designation "cooperative" will be used instead in all official publications and correspondence.

FORECASTS AND WARNINGS.

By Prof. E. B. Garriott, in charge of Forecast Division.

Unusually severe weather prevailed along the transatlantic steamer routes during the first half of April. During the second decade of the month barometric pressure continued low over the eastern Atlantic, and a disturbance moved from the ocean west of the British Isles southeastward over France. Following this disturbance an area of high barometer settled slowly southward over the British Isles and adjacent ocean. After the 24th pressures continued generally low over the British coasts. In the vicinity of the Azores the barometer was low until the 12th, and continued high from that date until the close of the month. Over the western Atlantic low and fluctuating barometric pressure attended the passage of a number of disturbances from the American Continent.

In the United States a remarkable succession of barometric depressions caused exceptionally heavy rains in the Southwest, and during the third decade of the month severe storms of rain and snow in contiguous mountain districts resulted in floods in parts of Arizona and western New Mexico. The eastward advance of depressions from the West and Southwest was attended by extensive rain areas, and followed by frost-producing cool waves of unusual seasonal severity. Destructive winds that attended the depressions were confined principally to squalls that accompanied local storms.

The month opened with heavy rain over the middle and southern Rocky Mountain districts and the Great Plains and heavy snow in the mountains of Wyoming, Colorado, and northern New Mexico. Extending eastward the rain area covered the central valleys and the Lake region on the 2d and 3d, and reached the Atlantic coast on the 4th, where rain continued during the 5th. On the 6th snow fell in parts of New England and the Middle Atlantic States. The precipitation of this period attended low areas I, II, and IV, the tracks of which are traced on Chart II. On the 5th violent local storms occurred in Iredell and Rowan counties, N. C., during the passage of low area IV over that State.

Following the passage of the low areas referred to the temperature fell, and heavy frost occurred on the 7th in the Southern States.

From the 4th to the 10th a disturbance of moderate strength, low area III, crossed the continent, its path being confined almost entirely to the British Northwest Territory and Canada. From the 9th to 11th a disturbance, low area VI, advanced from Wyoming to the middle Atlantic and south New England coasts, attended by an extensive rain area and by thunderstorms in the central valleys and Middle Atlantic States.

On the morning of the 11th two disturbances appeared, one,

low area VII, over Manitoba, and the other, low area VIII, in the lower Rio Grande Valley. The northern disturbance moved slowly eastward over the Lake region to the St. Lawrence Valley by the 13th, and the southern low area passed eastward over the Gulf of Mexico and crossed the Gulf coast line near Pensacola, Fla., attended at that station by a barometer reading of 29.40 inches. By the morning of the 13th this storm had advanced to a position off Hatteras, and by the following morning the northern disturbance and the Gulf storm had apparently united over the ocean between Nova Scotia and Bermuda.

Attending low areas V, VI, IX, and X, unsettled weather prevailed in the Rocky Mountain districts from the 10th to the 15th. During the 14th and 15th the barometer rose rapidly in the Northwest, with a marked fall in temperature from the Rocky Mountains to the Mississippi River, and on the morning of the 15th freezing temperature occurred to northwestern Texas, and snow to southern Missouri.

On the 16th snow flurries occurred in the Ohio Valley and Middle Atlantic States, and on the morning of the 17th freezing temperature was reported in the northern portions of the east Gulf States, and frost as far south as northern Florida. This cool wave foreran high area VI and caused heavy damage to early vegetables and fruit in the east Gulf and South Atlantic States. Warnings of the frosts that occurred on the mornings of the 16th and 17th were issued on the 15th and 16th, respectively. One of the most important storms of the month, low area XII, crossed the United States from California to the southern New England coast from the 17th to 21st, attended by snow and high winds in the middle Rocky Mountain region during the night of the 19th, by an extensive rain area east of the Rocky Mountains, and high winds over the southern Lake region and along the middle Atlantic and south New England coasts. In the rear of this storm high area XIII moved from the British Northwest Territory over the central valleys attended by a cool wave that carried the line of freezing temperature to northern New Mexico and Kansas and caused frost as far south as the Ohio River and Virginia.

Heavy rain set in over the southern Rocky Mountain region during the night of the 22d and extended, with heavy snow and freezing temperature, over the middle Rocky Mountain district by the 23d, where precipitation continued until the morning of the 24th. Low area XIV, which occupied New Mexico during the dates named, moved to western Missouri by the morning of the 25th, carrying the rain area over the Mississippi and lower Ohio valleys and breaking a drought in Missouri. During the 24th and 25th a disturbance, low area XV, advanced from the lower Rio Grande Valley over the northwest portion of the Gulf of Mexico, crossed the Gulf coast line, and merged with the extensive depression that attended low area XIV.

From the 24th to the 29th low area XVI moved slowly from the British Northwest Territory to the St. Lawrence, where it united with low area XVII that had advanced from Nevada. During the night of the 27th low area XVIII, that appeared over western Kansas on the morning of the 27th, united over Kansas with number XVII. The passage of low area XVII was attended by a general rain and thunderstorm area in the central valleys, Lake region, and Eastern States, and by severe local storms, the most important of which was reported at Laredo, Tex., on the 28th, during the apparent development over the Rio Grande Valley of a secondary disturbance, low area XIX, that moved eastward over the Gulf of Mexico by the close of the month.

NEW ENGLAND FORECAST DISTRICT.

There were no marked departures from the averages in the several elements of temperature, pressure, precipitation, and sunshine. Low barometric pressure predominated, the mean, 29.84 inches, being 0.11 of an inch below the normal of the district. The wind movement was considerably above the average, with a number of cold, blusterous days, characteristic of an earlier season. There were no severe storms or destructive gales. Storm warnings were displayed on the 5th, 15th, and the 21st, and there were no storms or high winds for which warnings were not ordered.—*J. W. Smith, District Forecaster.*

CENTRAL FORECAST DISTRICT.

No unusually severe storms crossed this forecast district during the month. Showers were frequent, though no very heavy rainfalls occurred. There were four marked general rain periods, viz, 3d–6th, 10–11th, 21st–22d, and 25–29th. Some damage was done in various localities by thunderstorms the afternoon and night of the 10th. Light frost occurred the 5th to 7th inclusive, 13th, and 15th, and heavy frosts the 8th, 16th, 17th, 18th, and 19th. The only damaging frosts were those of the 16th and 17th, when freezing temperatures were reported in many places. Frost warnings were issued well in advance of the several occurrences, and a special warning of freezing weather on the morning of the 16th. Snow fell on the 16th over the northern portion of the district.—*F. J. Walz, District Forecaster.*

NORTH-CENTRAL FORECAST DISTRICT.

The storm warning season opened on April 15. Previous to that date advisory messages were sent to open ports on Lake Michigan in advance of strong winds. During the latter half of the month the most severe storm which passed over the Lake region was the one that moved eastward from the Pacific coast over the middle Rocky Mountain region, and passed over the central valleys on the 20th and 21st, accompanied by high winds on the southern Lake region. Frost warnings ordinarily are not issued during the month of April in this district, but on account of the abnormally warm weather which prevailed during the latter part of March and the first part of April, advancing vegetation to a marked degree, such warnings were issued at various times, and the forecasts were usually verified. However, it is not thought that much protection could be secured. It is not known that the frosts seriously damaged vegetation, although the growth was much retarded.—*H. J. Cox, Professor and District Forecaster.*

WEST GULF FORECAST DISTRICT.

Several moderate disturbances which moved eastward across the interior of the country influenced weather conditions in the west Gulf States during the month. Brisk to high winds prevailed along the Gulf coast on a few dates, but no severe storms occurred. Warnings were issued for the high winds. Extensive and damaging frosts occurred over the northern portion of the district on the 16th, for which warnings were issued.—*I. M. Cline, District Forecaster.*

ROCKY MOUNTAIN FORECAST DISTRICT.

The month was cold on the eastern slope, while the precipitation was greatest of record for April in southern New Mexico and southeastern Arizona, and was exceeded only in 1900 in southeastern Wyoming, eastern Colorado, and northern New Mexico. High stages were reached in the streams of the eastern slope, and on the 25th notices of high water were sent to points on the lower Rio Grande. There were no cold waves; much colder weather was accurately forecasted for several dates, and freezing temperature for the districts in which vegetation was somewhat advanced.—*F. H. Brandenburg, District Forecaster.*

SOUTH PACIFIC FORECAST DISTRICT.

The month was, as a whole, free from marked disturbances. Over the valley of the Colorado unsettled weather and occasional heavy rains prevailed during the latter half of the month, causing delay to railroad traffic and numerous washouts. In northern California there was considerable cloudy weather, but a rainfall rather below the average. In southern California cloudy, cooler weather prevailed, with conditions favorable

for all crops. Except in southern California, no rain fell in California during the first nine days. On the 10th snow fell in the mountains, and on the 11th showers were general in California south of the Tehachapi. A hailstorm occurred at Los Angeles on April 11th. Moderate disturbances prevailed in California north of the Tehachapi April 15th to 19th. Heavy rain and snow fell in Nevada April 26th.—*A. G. McAdie, Professor and District Forecaster.*

NORTH PACIFIC FORECAST DISTRICT.

The month of April was unusually pleasant in the North Pacific States, and no storms of consequence or destructive winds passed over the district. Sharp frosts occurred on several mornings, doing considerable damage to early fruit and tender vegetables. As a rule, these frosts were accurately forecast.—*A. B. Wollaber, Acting District Forecaster.*

RIVERS AND FLOODS.

Ice disappeared from the rivers of New England and the Red River of the North about the 2d and 3d. There was little trouble from ice gorges. The ice rotted and melted, broke up when the waters began to rise, and passed away without gorging.

The Mississippi River was highest during the early portion of the month, and fell gradually during the last part of the month. Owing to heavy rains, the tributaries of the Mississippi began to rise at the headwaters during the latter part of the month, but did not reach danger-line stages.

Warnings were issued for the Red River on the 6th, the Trinity, Chichasawhay, Leaf, and Pearl rivers on the 25th, and for the Brazos on the 30th. The first warnings for the Rio Grande, in the new Denver district, were issued on the 25th. The high water was the result of the heavy rains and melting snow in the Southwest during the third decade of the month.

There was considerable snow at the close of April throughout the mountain districts of the Southwest, which may cause a considerable flow of water in the streams of that region as it melts. The snowfall in the northwestern mountain districts is unusually light, and but little water is looked for in the northern streams during the spring and summer.

The highest and lowest water, mean stage, and monthly range at 291 river stations are given in Table VI. Hydrographs for typical points on seven principal rivers are shown on Chart V. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—*E. B. Garriott, Professor.*

CLIMATE AND CROP SERVICE.

By Mr. JAMES BERRY, Chief of Climate and Crop Divison.

The following summaries relating to the general weather and crop conditions during April are furnished by the directors of the respective sections of the Climate and Crop Service of the Weather Bureau; they are based upon reports from cooperative observers and crop correspondents, of whom there are about 3300 and 14,000, respectively:

Alabama.—Weather generally favorable for work and growth, except that the cold of the 17th seriously damaged nearly all crops in northern counties; considerable cotton killed in middle district. Nearly all cotton planted, or replanted, with stands good and chopping well advanced by close of month. Upland corn, wheat, oats, and early and replanted minor crops advanced well. Lowland planting backward. Strawberries yielded well. Fruit a failure north, one-half to two-thirds average crop promised in middle and southern counties.—*F. P. Chaffee.*

Arizona.—Precipitation was largely in excess, and the temperature deficient. Heavy to killing frosts, 2d to 20th, resulted in slight injury to vegetables and fruit. Wheat, barley, and oats were well headed in southern counties last decade; in northern counties these crops were backward, owing to the continued cold and wet weather. All desert cacti blooming by the 25th. Garden truck was plentiful; water in abundance; ranges excellent; stock sleek and fat, with minimum loss. Fruit crop practically safe.—*L. N. Jesunofsky.*

Arkansas.—Excessive rains delayed farm operations over the greater portion of the State. As a result less than usual amount of cotton land was prepared and very little planting was done. Corn planting advanced fairly well and considerable corn was up to fair to good stands. Wheat, oats, potatoes, and grasses made satisfactory progress. Fruits and berries of all kinds were promising, except peaches in northwest portion.—*Edward B. Richards.*

California.—The temperature for the month was nearly normal and the precipitation slightly below average. The snowfall in the mountains was also less than usual. No severe frosts occurred, but the frosts at the close of March injured deciduous fruits considerably, and in some sections they were damaged by high winds and hailstorms during the latter part of April. Large shipments of cherries, strawberries, and asparagus were made to eastern markets.—*Alexander G. McAdie.*

Colorado.—Conditions were generally unfavorable. Excessive moisture retarded work and cold weather delayed germination and growth. Winter wheat remained in fine condition. Spring wheat was nearly all sown and growing nicely. Seeding of oats was well under way, some being up. Planting of sugar beets was backward. Some planting of potatoes was done. Alfalfa did well and grass was generally good. Fruits were backward, but coming into bloom; peach crop is expected to be light.—*F. H. Brandenburg.*

Florida.—Work progressed very well under generally favorable weather conditions. The month was 1° warmer than the normal, with about the average amount of precipitation. Rainfall was greatest in Lee County, and least over western counties of the northern district, where the monthly total was less than one inch. Cotton germinated to generally good stands, although some replanting was necessary as a result of cold weather. Corn advanced nicely; the early planting in southern counties was in tassel. Citrus trees made a good growth, although the prospects were that the crop would be short.—*A. J. Mitchell.*

Georgia.—The temperature was low on the 7th and below freezing in the northern half of State on the 17th and 18th; most of the fruit and tender vegetation killed; little damage southern half, where the outlook for fruit continued promising. Latter part of month warm. Rainfall well distributed. Spring planting almost completed; early corn up to good stand, being cultivated southern half, making rapid growth; cotton doing well, early planted nice stand, being chopped southern half State, acreage decreased considerably. Oats and wheat unusually fine. All minor crops good.—*J. B. Marbury.*

Hawaii.—Entire month showery and cool. Young cane made only fair progress, its growth being checked somewhat by cool weather. Harvesting and milling of mature cane proceeded rapidly, quality of juice indicating a larger yield of sugar than originally estimated. Plowing and planting for 1907 cane crop continued. Rice heading and ripening in Oahu; a good crop expected. Fruit for summer crop of pineapples developed very satisfactorily. Exceptionally fine coffee blossom during month. Pastures much improved.—*Alex. McC. Ashley.*

Idaho.—The rainfall was very unevenly distributed over the State, but was generally sufficient for crop growth. Farm work made good progress and vegetation at the close of the month was in advance of the season. Range grass was exceptionally good and stock made satisfactory gains. Frost caused some damage to early fruits, and in some instances to apples, but there remained a prospect for a fair to good crop.—*Edward L. Wells.*

Illinois.—Frost forming temperatures pervaded the State on the 16-17th, extending to the furthermost southern limits. Fruits and tender vegetation were only slightly damaged. The month ended favorably for germination and plant growth. The sowing of oats, begun early in the month, was practically completed at the end of the second decade, and at the end of the month the crop was showing a good stand. Plowing for corn was well advanced the latter part of the month, and some planting had been done. Wheat, rye, and grasses had made good growth and were very promising.—*Wm. G. Burns.*

Indiana.—Sowing oats began during the first week, but, owing to interruptions by snow and rain and delay on account of wet ground, was unfinished at the close. Wheat, rye, and hay crops were in prime condition. Seedling peaches and other fruit promised fair crops. Early potatoes were planted. A little corn was planted, but, owing to wet ground, plowing progressed slowly. An increased acreage of corn was planted.—*W. T. Blythe.*

Iowa.—The mean temperature for the State was slightly below normal and the daily weather was unusually variable. Conditions were favorable for farm operations, except in portions of the southern section, where there was an excess of moisture. Seeding of wheat, oats, barley, and flax was begun early and mostly completed before the 15th. Germination was retarded by brief cold periods, but a fair stand was secured. But little damage to fruit or cereals resulted from frequent frosts.—*John R. Sage.*

Kansas.—Wheat improved, beginning to head in extreme south. Oats

and barley all sown and up, showing good stands. Corn planting progressed well during the month; by the close of the month corn was up in southern and coming up in central counties. Potatoes planted; early planted up by the end of the month. Apples, apricots, cherries, pears, and plums bloomed well during the month. Grass improved slowly; alfalfa grew rapidly.—*T. B. Jennings.*

Kentucky.—Temperature near normal, with many warm days, yet several cold periods occurred. Month opened with farming operations and vegetation well advanced for the season. Wheat made excellent progress. Gardens, meadows, and pastures in excellent condition; oats and rye did well; tobacco plants promising. Good progress made in the preparation for and in the planting of corn, though hindered the latter part of the month by wet weather. Fruit trees blossomed with heavy bloom, though injured somewhat by freezing weather the 16-17th.—*F. J. Walz.*

Louisiana.—Frequent showers during the first and second decades kept the ground too wet for cultivation, and, as a result, farming operations were materially retarded. Cotton planting was not half completed in many sections at the close of the month. Corn planting progressed slowly. Sugar cane grew slowly, but looked well. Continued wet weather interfered with rice seeding. Crops were generally two to four weeks late. Truck gardens did well.—*I. M. Cline.*

Maryland and Delaware.—Temperature and precipitation averaged nearly normal. Warm, rainy weather prevailed first half, unfavorable, cloudy, and windy weather, with much low temperature, latter half of the month. Freezing temperature in every county on the 19th. At the close of the month wheat and rye were promising, grass very backward, oats coming up, and much corn ground prepared. Frost damaged cherry, plum, and peach prospects in northern and western Maryland and some southern localities, and killed early strawberry blooms in eastern counties. Apple trees developed heavy bloom by the 30th. Tobacco plants were plentiful.—*E. D. Emigh.*

Michigan.—Vegetation and germination made slow progress during the first two decades on account of cool, moderately dry weather. Warmer temperatures and moderately well-distributed showers during last decade started winter wheat and rye, meadows, and pastures nicely and forwarded germination. Field work made good progress throughout the month. Oat, barley, and pea seeding was well advanced, and early potato planting general, in the lower peninsula at the close of the month. Fruit buds were very promising.—*C. F. Schneider.*

Minnesota.—Most of the precipitation was before the 5th, and from the 26th to the 28th, with scattered snows in northern portions on 13th and 28th. Frozen soil delayed soil work almost every morning. At the end of the month spring wheat and oat seeding was practically finished, and the early seeded was coming up, with barley and flax seeding progressing well, and potato planting, gardening, and preparing for corn planting going on. All grasses growing slowly.—*T. S. Outram.*

Mississippi.—Farming operations were much hindered by excessive rains, which kept lowlands too wet to be plowed. Frost on the 17th damaged tender vegetation north. Considerable planting was done on uplands, where corn came up to good stands and by the close of the month was needing work. But little more than half of the cotton crop was planted. Oats made a thrifty growth. Strawberries yielded well. Minor crops and pastures did well. The outlook for fruits, except peaches, was favorable.—*W. S. Belden.*

Missouri.—In all sections of the State the month was favorable for farming operations. Killing frosts of the 15-17th resulted in more or less injury to fruits and early gardens. Corn planting was well under way in the southern sections during the first and second decades, and the wheat crop made excellent progress during the entire month. Cotton planting made fair progress, and oat sowing was completed about the 12th. Potato planting was completed during the earlier part of the month.—*George Reeder.*

Montana.—The month was mild, excepting a few cold days in the second decade. Very dry in eastern portion, frequent light showers in west, but not sufficient for vegetation owing to dry condition of soil from previous deficiency. Wheat seeding completed by 15th, much oats sown the latter part. Winter wheat, meadows, and alfalfa made fair progress. Cattle and sheep in good condition and turned on summer ranges in some sections. Planting of potatoes and garden truck begun.—*R. F. Young.*

Nebraska.—The first ten days of April were warm and farm work progressed rapidly under favorable conditions. Spring wheat and oats were mostly sown before the 15th The remainder of the month was cold, with several severe frosts, that damaged early fruit somewhat. The low temperature was unfavorable for the growth of oats and retarded corn planting. Only a very few fields of corn were planted in April. Winter wheat continued in fine condition.—*G. A. Loveland.*

Nevada.—The temperature and precipitation were both slightly below normal. The weather was generally favorable for farming operations the greater part of the month. Vegetation was about two weeks in advance of the average season at the beginning of the month. The soil conditions were fine for plowing and seeding. A severe frost on the 20th caused some damage to fruit blossoms in some of the western and southern districts.—*J. H. Smith.*

New England.—April was a very pleasant month, with more than the average number of fair and sunny days. While the temperature did not depart greatly from the seasonal average, the nights were considered unusually cool. The weather was very favorable to farm operations and to outdoor work generally. Much preparatory farm work was done and in southern sections considerable seeding and planting followed, but, owing to the cool, dry weather, germination and growth were slow—*J. W. Smith.*

New Jersey.—Temperature nearly normal; precipitation unevenly distributed and slightly below average. Month favorable for farming operations; plowing, planting, and seeding well advanced, especially in the southern section. Frequent killing frosts did some injury to early blooming strawberries, peaches, and asparagus; late orchard fruit trees uninjured—*Edward W. McGann.*

New Mexico.—A cool, wet month, with sharp frosts; some damage to early fruits, vegetables, alfalfa, and tender plants. Wheat, oat, and barley seeding and field pea, bean, corn, and potato planting continued throughout the month; early seeding came up well. Alfalfa and range grasses made rapid growth; alfalfa blooming in the southern valley at the close of the month. Stock improved rapidly generally, but severe losses occurred in northeastern counties. Lambing began in the second decade under very favorable grass and water conditions, and a large increase expected.—*Charles E. Linney.*

New York.—The weather during the month was generally favorable for farm work, but was too cool for the germination and growth of vegetation, which, as a result, was rather backward at the end of the month. The maple sugar season closed early and the yield was small. Winter grains and grass advanced fairly well, and the prospects were good for all kinds of fruit. Considerable oat sowing was done and a few potatoes were planted.—*H. B. Hersey.*

North Carolina.—Farming operations made fairly good progress during April, and the preparation of the soil for planting was advanced during every favorable opportunity. Much corn and cotton were planted. Tobacco plants in beds made slow growth. Wheat and oats improved materially. Killing frosts occurred on several dates, especially on the 17th, with much injury to fruit, tender truck crops, and young cotton. Shipments of early truck and strawberries began toward the close of the month.—*C. F. von Herrmann.*

North Dakota.—The month was slightly colder than usual, while the precipitation was the least ever recorded in April since the establishment of the service. Farm work was delayed considerably by the ground freezing at nights so that it could be worked only in the afternoon, but in spite of that seeding of wheat was quite well advanced at the close of the month.—*B. H. Bronson.*

Ohio.—The weather during greater portion of month unfavorable to farm work and best growth of plant life. During the last week of the month it was favorable, and at the close wheat was reported in fine condition. Pastures and meadows making good growth. Clover promising. Oat seeding well commenced, some early sown up and appearing in good condition. Corn planting well begun over southern portion. Planting of potatoes well under way. Tobacco plants backward. Fruit prospects generally fair.—*J. Warren Smith.*

Oklahoma and Indian Territories.—Temperature below, precipitation decidedly above average. Farm work and crop growth retarded. Wheat stooled, jointed, and headed out in good condition, with some rust reported; a fair to good prospect. Oats, barley, rye, and spelt in good condition. Corn planting retarded, early up to poor to good stand, but yellow, some cultivated. Cotton about one-third planted and coming up to poor stand, a decreased acreage. Alfalfa, potatoes, gardens, grass, stock, and fruit doing well.—*C. M. Strong.*

Oregon.—The month throughout was favorable for agriculture. Fall wheat making splendid advancement. Spring wheat, oats, barley, hops, forage plants, and pastures grew nicely. Summer fallowing and planting of potatoes, corn, sugar beets, and gardens were well advanced. Stock in fine condition. Increase of lambs above the average. Frosts during early part of the month considerably damaged peaches, prunes, and early cherries. Apple bloom lighter than usual.—*Edward A. Beals.*

Pennsylvania.—At the close of the month, plowing, oat seeding, and the planting of potatoes were well under way, and the soil was in good condition, except in the northern tier of counties; winter grain, meadows, and pastures were promising; garden truck was somewhat backward; corn planting had been started in some southern counties and fruit trees were blossoming satisfactorily. The damage from the frosts on the 19th was much less than anticipated.—*T. F. Townsend.*

Porto Rico.—Rain was urgently needed during the second and the third weeks for young vegetation. The showers of the latter part of the period put young canes in excellent condition, but hindered the reaping of the present crop in the northern sections. Grinding continued throughout the month; the grade of juice was slightly less than normal. Coffee blossoms were hindered by heavy showers, but the outlook for a good crop appeared promising. Some tobacco was harvested; quality fair. Pineapples and minor fruits were maturing.—*M. A. Robinson.*

South Carolina.—The month was characterized by periods of unusually low temperature and the latest killing frost on record, and by the general variableness of its weather. The precipitation was ample. Farm work suffered many interruptions, but planting operations were about as far advanced as usual, and good stands were generally secured, except of cotton, which was largely killed on the 17th by frost, which also dam-

SUMMARY OF TEMPERATURE AND PRECIPITATION BY SECTIONS, APRIL, 1905.

In the following table are given, for the various sections of the Climate and Crop Service of the Weather Bureau, the average temperature and rainfall, the stations reporting the highest and lowest temperatures with dates of occurrence, the stations reporting greatest and least monthly precipitation, and other data, as indicated by the several headings.

The mean temperatures for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperature and precipitation are based only on records from stations that have ten or more years of observation. Of course the number of such records is smaller than the total number of stations.

Section.	Temperature—in degrees Fahrenheit.								Precipitation—in inches and hundredths.					
	Section average.	Departure from the normal.	Monthly extremes.						Section average.	Departure from the normal.	Greatest monthly.		Least monthly.	
			Station.	Highest.	Date.	Station.	Lowest.	Date.			Station.	Amount.	Station.	Amount.
Alabama	63.6	+ 1.0	Flomaton Lucy	92 92	27 29	Valley Head	25	17	3.69	−0.48	Notasulga	6.72	Burkville	1.05
Arizona	58.0	− 3.2	Maricopa Parker	98 98	30 6	Fort Defiance	12	3	2.46	+1.90	Showlow	6.26	Aztec	T.
Arkansas	61.1	− 0.7	Howe	96	9	Pond	26	6	6.29	+2.13	Pine Bluff	12.53	Dodd City	2.10
California	57.2	+ 0.4	Bakersfield Volcano Springs	99 99	6 7	Bodie	6	2	1.18	−0.67	Delta	7.53	7 stations	0.00
Colorado	42.2	− 2.2	Las Animas	88	30	Whitepine	− 6	4	3.84	+2.56	Lake Moraine	8.70	Saguache	0.40
Florida	70.1	+ 1.0	Stephensville	98	19	Middleburg	32	18	2.52	+0.01	Marco	9.86	Monticello	0.90
Georgia	64.0	+ 0.9	Fleming	94	29	Clayton	26	18	3.33	−0.33	Dawson	6.31	Thomasville	0.82
Hawaii	†70.4	......	Waialua Mill, Oahu	91	20	Wahiawa, Oahu	50	12	‡5.96	......	Honomanu Valley, Maui	29.02	Waiawa, Kauai	0.01
Idaho	46.8	......	Garnet, Lewiston Lovell	83	24	Lost River Roosevelt	8 8	1 3	1.29	......	Grangeville	4.53	Ketchum	0.15
Illinois	52.1	− 0.1	Chester	92	9	Knoxville	20	5, 16	3.69	+0.60	Mascoutah	5.69	Benton	1.65
Indiana	51.7	− 0.5	Marengo Mount Vernon	87 87	28 3	Auburn Hector	20 20	8 16	3.75	+0.60	Anderson	5.22	Madison	2.21
Iowa	47.5	− 1.8	Clarinda	90	9	Inwood, Sibley	10	14	3.03	+0.14	Leon	5.49	Sibley	0.63
Kansas	53.2	− 1.5	Toronto	97	28	Colby	12	15	2.51	−0.33	Ulysses	6.10	Valley Falls	0.82
Kentucky	56.7	+ 0.4	Shelbyville	91	10	Farmers	23	8	3.00	−0.74	Mount Sterling	4.57	Hopkinsville	1.87
Louisiana	67.7	+ 0.7	Alexandria Oxford	93 93	26 27	Ruston	35	17	8.95	+4.78	Melville	18.90	Port Eads	2.68
Maryland and Delaware	52.8	+ 1.2	Boettcherville, Md.	88	10	Deer Park, Oakland, Md.	8	19	2.81	−0.45	McDonogh, Md	5.60	Boettcherville, Md.	1.07
Michigan	41.9	− 1.3	Gladwin	85	28	Humboldt	7	6	1.99	−0.04	Hillsdale	3.63	Petoskey	0.45
Minnesota	42.0	− 1.7	Hallock	79	26	Pokegama Falls	7	16	1.46	−0.93	Mount Iron	3.97	RedwingNo.2(Cline)	0.23
Mississippi	64.2	− 0.2	Woodville	92	26	Ripley	25	17	7.38	+3.21	Magnolia	14.59	Booneville	3.60
Missouri	54.9	− 0.1	Versailles Warrensburg	92	9	Goodland	20	17	3.19	−0.58	Sublett	7.79	Bagnall	0.79
Montana	43.2	+ 0.2	Ridgelawn	88	26	Grayling	− 1	2	0.90	−0.38	Nye	3.27	2 stations	0.00
Nebraska	46.5	− 2.9	Bartley	92	30	Agate	1	11	3.70	+0.93	Ansley	8.41	Nemaha	0.97
Nevada	47.0	− 1.5	Wabuska	85	22	Toano Eureka	10 10	1 10	0.84	−0.03	Lewer's Ranch	2.40	2 stations	0.00
New England*	43.7	− 0.7	4 stations	79	3 dates	Oquossoc, Me.	12	2	2.26	−0.68	Colchester, Conn.	3.89	Eastport, Me.	0.83
New Jersey	49.9	− 0.5	Indian Mills	84	21	Layton	18	3, 19	2.88	−0.55	Sandy Hook	4.03	Layton	1.53
New Mexico	49.5	− 2.8	Carlsbad	89	8	Elizabethtown	6	5	2.83	+2.04	Eagle Rock Ranch	5.90	Cambray	0.55
New York	43.6	− 0.1	Elmira	82	28	Faust	11	3	2.47	−0.17	Oxford	4.07	Ogdensburg	0.96
North Carolina	58.2	+ 0.8	Chalybeate Springs	92	29	Linville	20	19	4.07	+0.22	Edenton	8.20	Marion	1.95
North Dakota	40.2	− 1.0	Dickinson, Medora	83	26	Dickinson, Williston	3	16	0.63	−1.39	Forman	1.97	Willow City	T.
Ohio	48.5	− 1.4	Thurman	89	9	Cardington	12	8	3.10	+0.35	North Lewisburg	4.75	Rittman	1.68
Oklahoma and Indian Territories.	58.7	− 2.2	Chickasha, Ind. T.	98	24	Kenton, Okla	27	24	4.35	+1.58	Goodwater, Ind. T.	8.97	Jenkins, Okla.	1.12
Oregon	51.0	+ 2.9	Umatilla	90	24	Bend Riverside	16 16	11 10	1.12	−1.93	Bull Run	3.19	Grass Valley	0.03
Pennsylvania	48.4	+ 0.3	Aleppo	84	1	Lawrenceville	16	15	2.84	−0.40	Indiana	4.74	Harrisburg	1.39
Porto Rico	76.5	......	Mayaguez	98	19	Cidra Corozal	50 50	29 24	4.68	......	Lares	12.15	Cidra	1.12
South Carolina	62.8	+ 0.7	Walterboro	92	28, 29	Greenville	25	17	3.83	+0.22	Columbia	7.51	Barksdale	2.00
South Dakota	44.7	− 1.7	Kimball	87	7	Canton	8	14	1.23	−1.33	Elk Point	2.34	Fort Meade	0.49
Tennessee	58.7	+ 0.1	Johnsonville	91	28	Erasmus, Hohenwald	18	17	3.47	−0.89	Memphis	5.83	Nashville	1.50
Texas	64.5	− 2.0	Fort Ringgold	100	11	Clarendon	22	5	6.32	+3.44	Waco	13.01	Fort Ringgold	0.11
Utah	48.7	+ 1.0	Grayson	88	19	Government Creek	9	1	1.47	−0.31	Alpine	3.98	Trout Creek	0.25
Virginia	55.2	+ 1.3	Staunton	89	11	Burkes Garden	19	19	2.75	−0.56	Hampton	5.76	Greenwich	1.19
Washington	50.7	+ 2.1	Hatton	99	24	Northport	18	10	0.96	−1.70	Clearwater	3.05	Sunnyside	0.00
West Virginia	52.2	+ 0.6	Logan, Sutton Williamson	89	10	Bayard	14	19	2.78	− 0.30	Pickens	5.57	Moorefield	1.10
Wisconsin	43.5	− 1.8	Prentice	80	26	Amherst Koepenick	10 10	7 6	1.36	−1.11	Racine	4.05	Downing	T.
Wyoming	39.4	− 1.0	Torrington	84	30	Lake Yellowstone, Y. N. Park	−10	11	2.41	+0.74	Pine Bluff	6.71	Embar	0.40

* Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut. † 47 stations, with an average elevation of 497 feet. ‡ 128 stations.

aged fruit in the western counties. Wheat and oats became promising. Most of the tobacco crop was transplanted.—*J. W. Bauer.*

South Dakota.—Though seeding operations were interrupted by unfavorable conditions, the month closed with spring wheat seeding finished and the sowing of oats, barley, and spelt fast nearing completion. Cool weather, and the latter part of the month dry surface soil, retarded growth of all vegetation. Early spring wheat, oats, barley, and spelt were in good condition, but insufficient moisture prevented prompt and even germination and growth of the later sown. Grass was backward and pasturage short, but live stock looked well. Plowing progressed satisfactorily. Potato planting was well advanced.—*S. W. Glenn.*

Tennessee.—Killing frosts about the 6th and 17th were very injurious to tender vegetation. Conditions were much more favorable during the last decade, and at the close of the month reports of crop conditions were very encouraging. Planting of corn and cotton was in full progress and some early plantings were up, with good stands. Strawberry shipments had begun. Wheat, oats, and clover were in fine condition of growth. Tobacco plants were growing rapidly. Truck crops were recovering from frost damage. There were some apples and peaches in highland sections.—*H. C. Bate.*

Texas.—Weather early in the month was fairly good for farm work, but showery weather later interrupted work. Cool early in the month, with frosts in northern and central counties, followed by warmer late in the month. Damage by frost slight, and crops largely recovered during the warmer weather. Cotton planting delayed by showers, and much replanting became necessary; crop fair to good in southern counties, but less favorable in northern and central counties. Other crops did fairly well, but corn was foul and rust appeared in wheat and oats. Grass did very well and stock improved greatly.—*M. E. Blystone.*

Utah.—Cloudy and changeable weather prevailed during the month, with frequent storms that thoroughly soaked the ground and retarded all farm work. Nevertheless, crops were in fine condition and making rapid growth. Seeding was still in progress, though nearing completion. Fall and early sown spring wheat were coming up well. Fruit was backward, though generally looking well, excepting peaches and apricots, which suffered severe damage from the cold weather in February. Sheep

shearing was nearly completed, with the clip excellent. The range was fine and stock thriving.—*R. J. Hyatt.*

Virginia.—With the exception of a cold period from the 17th to 19th, when killing frosts and ice occurred, and a local droughty condition during the month in portions of the great valley division, the general weather prevailing through the month was favorable for crop progress. Winter wheat and oats advanced steadily, and field work incident to the season was vigorously carried on. Some corn was planted and tobacco plants were abundant and thrifty. Gardens, truck crops, and fruit were considerably injured by frost.—*Edward A. Evans.*

Washington.—The weather was too dry in most localities to favor the rapid growth of vegetation, and, although a warm April on the average, there were such cool and frosty nights as to retard the progress of crops considerably. Some of the frosts, notably those of the 9th and 10th, were killing to early vegetables and certain fruits, such as cherries and prunes. Winter and spring wheat, barley, and hops made satisfactory progress, while grass, oats, gardens, and field potatoes grew slowly.—*G. N. Salisbury.*

West Virginia.—Light snowfall and freezing temperatures were general over the State from the 16th to 19th, but at other times the weather was fine and pleasant. At the close of the month wheat, rye, and grass were in very fair condition, and plowing for corn had progressed rapidly. Oat sowing was about completed, and potatoes were coming up. Some cherries, plums, and pears were killed by the freeze, but the prospects for peaches and apples, especially the latter, were better than expected.—*E. C. Vose.*

Wisconsin.—The month was colder and drier than usual, with freezing temperature generally over the State on the 6th and 7th. No serious damage occurred, as vegetation was not sufficiently advanced to be liable to injury. Winter wheat, rye, and grasses made good progress. Seeding of oats, barley, spring wheat, and spring rye was generally completed by the middle of the month, except in extreme northern counties. Preparations for corn and potatoes were well advanced by the end of the month.—*W. M. Wilson.*

Wyoming.—Over most of the State the month was too cool for the growth of crops and ranges, and in some portions of the southern counties the soil was too wet to work, and seeding was delayed. The heavy rains and snows caused some loss of lambs, calves, and shorn sheep, but were of great benefit to meadows and ranges. By the close of the month early sown grain was up and looking green, while in some sections seeding had not been completed.—*W. S. Palmer.*

SPECIAL ARTICLES.

STUDIES ON THE DIURNAL PERIODS IN THE LOWER STRATA OF THE ATMOSPHERE.

III.—THE DIURNAL PERIODS OF THE VAPOR TENSION, THE ELECTRIC POTENTIAL, AND COEFFICIENT OF DISSIPATION.

By Prof. Frank H. Bigelow.

THE DIURNAL VARIATION OF THE VAPOR TENSION.

In the Monthly Weather Review for December, 1902, I made some remarks upon the phenomena involved in the changes of the semidiurnal periods of the barometric pressure, the atmospheric electric potential-fall, and the vapor tension, as they occur at the surface of the earth, into the simple diurnal periods which are observed in the strata above the ground. The present series of papers properly supplements that paper, but in this connection attention is fixed upon the annual variations in these two related periodicities for the purpose of determining the exact physical processes operating to produce the transformations recorded in those periods. Especially it is proposed to lead up to an explanation of the diurnal periods in the earth's magnetic field, which seem to be simply a meteorological effect of the radiation of the sun in the lower strata of the atmosphere, through the intermediate development of currents of electric ions in connection with the prevailing distribution of the temperature.

The hourly values of the vapor tension at the surface were not available at the Blue Hill Valley Station, and I decided not to take Boston, preferring a more inland station which should be freer from seacoast influences. In consequence of the convenience of the published record at Parc St. Maur, Paris, the mean diurnal variations of vapor tension at that place for the five years, 1897–1901, were computed, the results being given in Table 3. These variations at each hour relative to the daily mean are transferred to the curves of figs. 38–49, being the lower curve of each month. In order to obtain the hourly values of the vapor tension in the free air for the levels 195, 450, and 1000 meters at Blue Hill, I proceeded as follows: The temperatures computed at these elevations in Fahrenheit degrees were read from figs. 14–25, and they may be recovered from Table 2, by reversing the sign of ΔT as there recorded. These temperatures were converted into degrees centigrade. With this as an argument the vapor tension E was taken from Table 43 in the Smithsonian Meteorological Tables, edition of 1896, for saturation. Then, with the observed relative humidity at these levels for each hour, the corresponding vapor tension, $e = E \times R. H.$, was computed, and the results are given in Tables 4, 5, and 6. These variations of the vapor tension above the surface are also transferred to figs. 38–49, the mean monthly values appearing on the zero line, and the ordinate divisions being 0.40 mm. The values of the relative humidity in the free air at Blue Hill were extracted from the same report, and for each month, at the levels 195, 400, 1000 meters, all the available data were collected. Certain interpolations were made from observations at other heights, when practicable, in order to obtain more material for the discussion. The means were taken at each hour, and plotted on diagrams, and average lines were drawn through the points, from which approximate values were found. Then these values of the relative humidity for the hours 12 a. m., 4 a. m., 8 a. m., 12 p. m., 4 p. m., 8 p. m., were placed on a second system of sheets with the months as one argument, and mean lines were drawn. From these curves, which smoothed out minor irregularities, the second approximate hourly values at six points were found, and transferred to the first system of curves, which were reconstructed by the aid of them. This method of double cross-plotting involving two approximations, as before stated, is capable of dealing successfully with very rough data. An examination of the set of curves in the figs. 38–49 "Diurnal variation of the vapor tension, Δe, in the four levels 50 meters, Parc St. Maur, Paris, 195 meters, Blue Hill summit, 400 and 1000 meters in the free air over Blue Hill," leads to the following remarks on the behaviour of this element in the lower atmosphere.

(1) The mean vapor tension for the day decreases from a maximum at all levels in July and August to a minimum in the same levels in February, and from a maximum at the surface in each month to a series of lower values with the increase in elevation. This course is parallel with the seasonal change in the temperature, as may be seen by comparing the series of curves in figs. 14–25. The vapor content of the atmosphere is strictly a function of the temperature and the sources of evaporation of aqueous vapor, but for any given locality it is a function of the temperature alone when general averages are considered.

(2) For the diurnal period at the surface the year divides into two portions: first, November to February, when the diurnal variation has a single maximum, about 3 p. m., and a single minimum, about 6 a. m.; second, March to October, when the semidiurnal period is developed with maxima about 8 a. m., 8 p. m., and minima at 4 a. m. and 3 p. m., approximately. In March the maxima are located more closely together, also in October, than in the other months, showing that there is in this connection a transition between the single diurnal and the semidiurnal periodic systems. By comparing these curves with the series of figs. 2–13, "Temperature-falls in the lower strata," it is seen that the fully developed maxima of the vapor tension occur exactly in the midst of the hours of the most rapid temperature changes, 8 a. m., 8 p. m. When the lower atmosphere is heating most rapidly from the surface upward, convection currents form, which rise in the forenoon, carrying the products of fresh evaporation with them as an increase in the vapor tension. The surfaces covered

with dew and moisture deposited during the night are in a favorable condition for rapid evaporation. The first heat of radiation on the ground acts primarily on the vegetation and fills the air with vapor as fast as the process of evaporation can proceed. The midday minimum occurs at the time of greatest effective temperature, but it is a minimum for the vapor tension because the supply of moisture for evaporation is not sufficient to keep the same degree of relative humidity at the higher temperature then prevailing. The vapor contents that rise in the first wave are carried aloft to about 2000 meters, or the height of the diurnal temperature effect, and there is not sufficient aqueous vapor at the surface to fill the air undergoing this rapid temperature change up to an equal relative humidity. The second maximum at the surface is due to a reverse process of cooling, which begins at the ground and occurs most rapidly at 8 p. m., as is seen from figs. 2–13. The convection currents at that hour are directed earthward and bring the aqueous vapor back to strata which are lowering their temperature, and, therefore, develop a higher relative humidity. This cooling action extends upward slowly, with a considerable time lag, until it gradually dies out within a few hundred meters of the ground. The single maximum of the upper strata seems to be the continuance of the forenoon maximum in the lower strata, and, except for June, July, and August, the afternoon second maximum does not develop higher than 400 meters. The entire system groups itself about the curves of the temperature-fall in a very harmonious manner. The vapor rises along the ascending slope of the temperature variation and falls again on the descending slope. This is seen clearly in the summer months, where the time of the sun's radiation covers the hours from 5 a. m. to 7 p. m. In the winter these hours are much contracted, and, the temperature being relatively low, the vapor tension has much less chance to produce the double maximum, since the true vertical convection currents are comparatively feeble.

(3) In the winter there is a marked inversion of the vapor tension in the stratum 195 meters, the summit of Blue Hill, as referred to that at the ground 50 meters, or at higher elevations 400, 1000 meters, such that a minimum occurs during the middle of the day and a maximum at night. This appears in December, January, February, March, and April; in the other months, the rising forenoon maximum reverses it back again. Whether this is a characteristic of the free air at this level, or is a peculiarity of Blue Hill summit, it is not easy to determine. It may be noted that while the mean vapor tension decreases with the height, the amplitude increases at the given elevations. The lower temperature of the higher strata causes the vapor tension to be more sensitive to masses intruding from below. The same amount of aqueous vapor will cause a greater change in the tension at low temperatures than at high, and hence the vapor contents rising from the ground causes greater amplitudes in the variation of the hourly values in proportion to the height. Thus, in July a temperature of 65°, with range from 56° to 78°, is accompanied by a change in the vapor tension $\Delta e = 0.70$ mm. at the ground, while at 1000 meters the mean temperature of 60°, with range from 57° to 62°, is attended by a variation $\Delta e = 3.50$ mm. There are numerous other circumstances which can be deduced from these diagrams, such as the gradients at each hour in the day between the different levels; the function of the vapor tensions relative to the temperatures in the free hour; the effect of the surface in disturbing free air conditions which it would be beyond the purpose of these papers to discuss at this time.

THE DIURNAL VARIATION OF THE ELECTRIC POTENTIAL GRADIENTS.

The three series of observations of the hourly values of the atmospheric electric potential gradient, that is, the fall in volts per meter, $-\frac{dV}{dn}$, which have been examined in this connection are those at Perpignan[1], Paris[2], and Greenwich[3] for the five years, 1896–1900, inclusive. For Perpignan and Paris the curves given in fig. 50 were copied from the diagrams contained in the works referred to above; while for Greenwich the data for the clear and rainy days combined, as well as for the clear days by themselves, were extracted from the annual reports; the results appear for each month in fig. 51, the clear and rainy days are printed in dotted and the clear days alone in black lines. No attention has been paid to the absolute values in volts, as it is proposed simply to discuss the causes of the maxima and the minima, rather than the amplitudes of the curves. The figs. 50, 51 show that a maximum occurs during the forenoon hours, 7 to 11 a. m., and a second maximum is found in the evening hours from 6 to 11 p. m. The Perpignan and the Paris curves suggest that the morning maximum occurs earlier by about two hours in summer than in winter, while the evening maximum is more steadily centered at 7 to 8 p. m. The Greenwich curves, on the other hand, indicate that there are really two maxima in the forenoon, and two maxima in the evening, though there is a tendency to suppress the first morning maximum at 8 a. m. in the winter, which gives this maximum the appearance of entering earlier in summer than in winter as on the French curves. The evening double maximum seems to show that the 10–11 p. m. crest is steadier than the 7–8 p. m. crest throughout the year. We have therefore to give an account of the variable 8 a. m. and 8 p. m. crests, and the comparatively steady 11 a. m. and 11 p. m. crests.

Before proceeding with this exposition, I will further introduce some curves of the daily variation of the rate of dissipation of the electric charge, $q = \frac{a-}{a+}$, as given by Zölss[4], and by Gockel[5], in the Physikalisches Zeitschrift. They appear in fig. 52 for Kremmünster in the winter, and for Freiburg in the summer and the winter. While the observations are not sufficient in number to settle definitely the normal maxima and minima, yet they appear to indicate two crests in the forenoon, 8 a. m. and 10–11 a. m., and two in the evening, 8 p. m. and 10–11 p. m., with a fifth crest about 3 p. m., as is the case with the atmospheric electric potential.

There is yet another fact which can be brought out by comparing the annual numbers of the atmospheric electric potential at Greenwich with the well known variation of the annual prominence numbers, as given by me in the Monthly Weather Review for November, 1903. The Greenwich numbers are taken from the annual reports of that observatory, and are to be found in Table 9, "Variation of the atmospheric electric potential numbers on an arbitrary scale". For the years 1881-1888 the scale seems to be different from that of the years 1890-1901 in about the ratio of 1 to 2, and I have multiplied the first set by the factor 2 to give about the same amplitude for the entire series, because the location of the crests will not be altered. There are three columns, for "All days", "Rainy days", and "Clear days", respectively. These data are plotted in fig. 53, "Annual variation of the number of solar prominences and the atmospheric electric potential," but the potential curves are plotted in an inverse sense to that of the prominences. This implies that an increase in the solar activity, which produces the prominences, at the same time operates to reduce the normal atmospheric electric potential near the surface of the earth. The number and the location of the crests

[1] Des Variations de l'Électricité atmosphérique a Perpignan, par le Docteur Fines, 1890, Comptes Rendus.

[2] Étude de la variation diurne de l'Électricité atmosphérique, Par M. A.-B. Chauveau, 1902, Bureau Central, Paris.

[3] Greenwich Magnetical and Meteorological Observations.

[4] Phys. Zeit. 5, No. 10, p. 259.

[5] Potentialgefälle und elektrische Zerstreuung in der Atmosphäre. A. Gockel, Phys. Zeit. 4, No. 30, pp. 871-876; and 5, No. 10, pp. 257-259.

make this inference probable for these two elements. We have already shown in various places, summarized in the same paper, Monthly Weather Review, November, 1903, that the force of the deflecting magnetic vector *s* has a variation in its annual numbers which is in synchronism with that of the prominence curve. Hence, the magnetic field varies directly, while the electrostatic field varies inversely, to that of the solar energy, as shown by the frequency of the prominences, faculas, spots, coronas, and the intensity of the radiation generally.

I have brought together the several typical curves, such as emerge from an inspection of the charts and the figures of the preceding data, in fig. 54, Section I, "Comparison of the diurnal periods of temperature-fall, pressure, temperature, vapor tension, electric potential, and coefficient of dissipation". They are to be regarded as normal types of periodicity such as occur generally most vigorously during the summer months. The temperature-fall curve is from figs. 2-13, as for July; the semidiurnal pressure and temperature curves are from figs. 26-37, with some little change in the amplitudes; the vapor tension curves are from figs. 38-49, and are those for the 50, 195, and 400-meter levels in the midsummer; the electric potential gradient is from fig. 51, and the coefficient of dissipation is from fig. 52. It should be remembered that the relative values of the ordinates vary as follows:

An increase of the ordinate upward means—

(1) A greater temperature-fall, or lowering of temperature.
(2) An increase in the pressure.
(3) A decrease in the temperature.
(4) An increase in the vapor tension.
(5) An increase in the electric potential.
(6) An increase in the coefficient of dissipation.

From fig. 54, Section II, we learn that the double crests of the electric potential and coefficient of dissipation belong one to the temperature-falls at 8 a. m. and 8 p. m., and the other to the pressure-rises at 10-11 a. m. and 10-11 p. m., while the 3 p. m. crest seems to be associated with the reversal of these curves at the time of the two minima in the afternoon. The 8 a. m. and 8 p. m. temperature maxima occur in the midst of the most rapid temperature-rise in the forenoon, and the most rapid temperature-fall in the afternoon. The semidiurnal pressure curve lags about two hours behind the temperature effect, and it must be closely associated with the dynamic effect of rapidly rising and falling vertical convection currents. The exact process involved in this retardation is worth a special investigation. The vapor tension curve, also due to temperature action in producing vertical convection currents, lags yet farther behind the temperature cause, the retardation increasing from three hours at the surface to four or five hours at higher levels. It is pointed out that this physical convection in time between the vertical and horizontal coordinates affords a means of computing the vertical velocity of the heads of the effective waves of the several kinds. One must, however, take careful note of the circumstance that the entire system is being propagated from right to left on the diagram with a velocity proportional to the linear velocity of the earth's rotation at the latitude of the station. The night effect is overtaken by the advancing cone of the day temperature waves, and this makes the vertical retardation fall to the right in ascending from the base line of the abscissas.

From these considerations it is evident that we are dealing with a temperature effect throughout this series of phenomena, and that it is confined to the lower strata of the atmosphere, within two miles of the surface, because the diurnal variation of temperature is not efficient above that level. Hence, we must conclude that they are all consequences of the solar radiation, which, as is generally admitted, is the cause of the variation of the diurnal temperature by indirect action from the ground.

I have been thus careful to explain that we are concerned simply with the lower strata of the atmosphere, and have nothing to do with the higher strata, because in the following paper I shall be able to show that the diurnal variation of the magnetic field is also a temperature effect in the lower strata of the atmosphere. We may now make some further remarks on the physical cause of the atmospheric electricity of the earth's gaseous envelope.

THE CAUSE OF THE ELECTRICITY IN THE EARTH'S ATMOSPHERE.

A brief account of some of the relations between the ionization and electric potential of the atmosphere can be found in the 4th chapter of my report on "Eclipse Meteorology" Weather Bureau, Bulletin I, 1902; see also the report by M. A. B. Chauveau, already referred to, and several papers by H. Ebert, Elster and Geitel, P. Lenard, C. Barus, and others, containing the views which have been advanced recently to account for this elusive phenomenon. It is conceded that + ions and — ions are normal constituents of the atmosphere, and that their generation and recombination, with the attendant motions of their electric charges, form the basis of this physical process. These ions are produced in very many ways in the temporary disintegration of the dynamic structures of the molecules and atoms, by which they are temporarily detached and move about in search of new places of neutralization. The most prolific source of their formation is probably the action of the short waves of the solar radiation upon the aqueous vapor of the atmosphere, whether visibly condensed or in the invisible state. There is, also, a further source of the ions in the action of the electromagnetic field of the sun operating upon the electric and the magnetic fields of the earth within the gaseous materials of the atmosphere. The complexity of the physical process is very great, and I shall confine my attention more to the modes of redistribution of the ions found in the air, and moving as currents of electricity, than to their original formation. Electric potential gradients are due to a separation of the positive and the negative charges, and ultimately the source of this energy will go back to some transformation of gravitational force. At present, the inquiry culminates in the necessity of accounting for the negative charge of the earth, which is doubtless a very difficult problem. I shall make the following suggestions regarding it.

THE NEGATIVE CHARGE OF THE EARTH.

Elster and Geitel's theory of the atmospheric electric potential assumes that the negative ions when produced in the atmosphere move to the earth, which is a conducting body, more rapidly than the positive ions, and that their accumulation upon it produces the observed charge. This surface charge, it is inferred from Linss's experiments, now verified, dissipates at the rate of discharging itself, on the average, in 100 minutes. But the researches of Simpson (Phil. Mag. 6, 589, 1903) Ebert and Ewers (Phys. Zeits. 5, No. 5, p. 135-140) throw doubt upon this view, because they have not been able to show that a conductor in ionized air receives any charge by the absorption of either kind of the ions surrounding it. Ebert, on the other hand, seeks to supply the surface charge of the earth by referring the source to radio-active constituents within the earth, which, discharging through the porous ground by the capillary action of the narrow channels, deposits the negative charges on the sides, while the positive charges are ejected. It is not clear that this process is applicable to the great oceanic areas of the earth, though these show about the same electrical gradients as the land areas, nor would this process appear to allow the negative ion contents to accumulate sufficiently in the strata of the air at some distance above the ground, to produce the high tension observed in lightning discharges and in nondisruptive strains.

There are, however, several other processes which probably contribute to the separation of the positive and negative ions,

by which the former tend to accumulate in the atmosphere and the latter at the surface of the earth.

(1) The different masses of the + ions and the — ions, the + ions being much larger than the — ions, may have a differential relation to the mechanical light pressure due to electromagnetic radiation, and it is possible that the negative charges are driven before it, within the earth's atmosphere itself, more abundantly than the positive charges. If the incoming solar radiation produces + ions and — ions excessively upon impact with the top of the aqueous vapor arch, which is near the surface of the earth in the polar zones and high above the ground in the Tropics, then the — ions may be driven to the earth by the mechanical pressure of the light, while the + ions tend to remain in the higher strata. Although this is not quite parallel to the case of the formation of cathode streams in rarefied gases or the comet tails in free space, there may be some differential action of this kind that tends to separate these two kinds of ions, carrying the negative ions to the earth.

(2) Since fresh ions are produced in some way by the radiation in the existing electrostatic field, V, surrounding the earth, therefore the velocity of the motion of the nucleus carrying the charge, e, where the radius of the nucleus is R and the viscosity of the air is μ, is determined by C. Barus from the formula,

$$v = \frac{Ve}{4\pi\mu R}. \quad \text{(Science, January 2, 1903.)}$$

For $R = 10^{-6}$, $\mu = 0.0002$, $e = 200 \times 7 \times 10^{-10}$ $E.S.U.$, $v = 37$ cm/sec = 0.8 mile per hour, for the unit electrostatic field = 0.003 mile per hour for a field of 1 volt/cm. Hence, by changing the sign of e, the ion charge in the formula, those of one sign would be driven in one direction and those of the other sign in the opposite direction. This is evidently one true cause of the observed separation.

(3) Similarly, the + ions and the — ions, being generated in the free air by radiation in the midst of the magnetic field surrounding the earth, should be driven in opposite directions along the lines of force to the polar regions. As the electrostatic field tends to separate a swarm of + ions and — ions in radial directions, the + ions to higher strata and the — ions to earth, so the magnetic field tends to send + ions to one polar region and the — ions to the opposite polar region. In fact, these electric and magnetic lines of force are the natural highways of travel for the ion content of the air, and, in a word, it is my opinion that the ions are generally moving about from one place to another while they are free from the bonds of atomic and molecular combination. Of course the temperature, vapor content, and pressure may accelerate or impede these movements, as has already been pointed out by Elster and Geitel, Ebert, Gockel, and others, and so introduce the meteorological conditions which have been observed. The ions in this way become sensitive registers of the physical variation in the atmosphere, and have much interest to the meteorologist.

(4) There is yet one more cause for the earth's electric surface charge which may be the most important of all, and that exists inside the earth in the atomic circulation within its mass. W. Sutherland[6] has indicated that the static electric charge of the earth, and its magnetic field may be due to a slight displacement of the positive and the negative body charges, through a distance comparable to the diameter of a molecule, 10^{-8} cm., whereby the negative charge of the earth, as a whole, is that distance farther from the center than the positive charge. There seems to be much difficulty in understanding how this takes place physically in the earth, which should apparently be electrically conducting under high temperature and pressure, but it may be possible to escape from this criticism by resorting to the following modified conception of a dynamic rather than a static character.

It seems to be probable that atoms of matter are constituted of negative ions circulating rapidly, in connection with a larger, more inert positive charge, either inside or outside of it. The velocity of rotation of the — ions is greater than the + ions and this would imply that there is a tendency for some of the negative ions to pursue paths of larger radii than the positive ions, and also at greater angular velocity. Thus, they ought, in one way or another, to recede farther from the center of the earth than the positive ions, but in so far as their natural orbital motions are impeded they will tend to accumulate and become static charges nearer the surface of the earth. If these circulating ions, the negative ions moving more vigorously, have a tendency to become polarized as to their orbit, that is to circulate in planes perpendicular to the axis of the rotation of the earth, through the effect of the earth's deflecting force due to its own angular velocity, then, there should be integrated a resultant true magnetic field directed from north to south through the interior of the earth. It is quite likely that Southerland's view can be modified from the electrostatic basis proposed by him to this electrodynamic basis, with resulting static negative residual charge at the earth's surface, and magnetic field within the earth, sustaining that observed outside of its surface. Should this be the case, it must be inferred that similar processes go on in the sun and the stars, and that all large rotating celestial bodies are polarized magnetic spheres, with electrostatic charged surfaces. The variation of the distribution of these charges from time to time, and from region to region, constitute the source of the periodic and aperiodic disturbances with which we are becoming familiar in several different classes of observations. To whatever extent these processes are in operation within the earth, and in its atmosphere, as here outlined, and thus cause the observed general distribution of the positive electric charge in the higher strata, with the negative charge at the surface of the earth, we may properly consider the variation of the electric gradients in the atmosphere as a phenomenon resulting therefrom, in consequence of changes in the temperature conditions in the earth and in the atmosphere.

THE PERIODIC VARIATIONS OF THE ELECTRIC POTENTIAL GRADIENT IN THE EARTH'S ATMOSPHERE.

I have called attention to the fact that the electric potential gradient varies from year to year inversely to the solar prominence numbers, and, in consequence, inversely to the strength of the solar radiation, insolation, and terrestrial temperatures. An increase of the temperature of the lower atmosphere decreases the potential tension between the masses of the positive and of the negative ions. Similarly the potential gradient is greater in the polar regions of the earth where the air is cold, than at the equator where it is warm. At any given station the gradient is greater in winter than in summer. Generally, cooling the air is favorable to producing an increase of the electrical gradient. Likewise, it will be seen by referring to figs. 26–37, 50, 52, 53, 54 that the diurnal maxima of the electric potential occur at the times of the true minima of the temperature waves, 8 a. m., 8. p. m., or as modified by the correlative pressure maximum waves occurring two hours later, 10 a. m., 10 p. m. We may, therefore, conclude that one uniform physical process is concerned throughout this series of electrical gradient transformations, namely, *the air is cooled in some way whenever there is an increase of the electrical gradient.*

(5) It seems to me but a step to arrive at an equally general and valid theory of the variation of the electric potential. We need only admit that the positive ions have a stronger affinity for a gas at low temperature than for the same gas at a higher temperature. If the + ions seek regions of low temperature and the — ions move to the regions of high temperature, we have yet another cause, in addition to the four already men-

[6] A possible cause of the earth's magnetism, Terr. Mag. June, 1900. June, 1903. December, 1904. W. Sutherland.

tioned for the separation of the positive and the negative ions into two masses. Hence, in the diurnal waves of temperature the positive ions flow downward from their normal level to a lower level as the minimum of the temperature wave in the lower strata passes over the place. This implies that at the 8 a. m. and 8 p. m., local hours, a stream of + ions is directed downward, so that the positive ions as a mass approach more nearly the surface of the earth where the negative ions are already accumulated. Hence, the potential gradient of electricity will be increased in proportion to this approach. It seems that the negative stratum may be considered as quite steady in elevation, while the positive stratum rises and falls in a wave, synchronously with the passage of the temperature wave. Referring to Section III, fig. 54, the temperature curve of Section I has been plotted once more in the reverse position, to show the approach of this cold stratum to the earth. From this exposition of the facts, I assume that a current of + ions descends at 8 a. m. and 8 p. m. with the temperature wave, and that the same ions ascend at 3 a. m. and 3 p. m., while the − ions remain all the while at about the same level. This, evidently, causes the observed increase and decrease of the electric potential as observed at the surface during the 24 hours of the day. I see in the movement of the + ions from one elevation to another, while the − ions remain on or near the charged surface of the earth, the true cause of the diurnal variations of the atmospheric electric potential.

TABLE 3.—*Diurnal variation of the vapor tension at Parc St. Maur, Paris.*

Hours.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
12 a	−.10	0.0	+.08	+.23	+.17	+.18	+.14	+.16	−.02	−.19	−.17	−.02
1	−.08	−0.5	+.01	+.16	+.03	−.01	+.08	+.16	−.09	−.18	−.16	−.07
2												
3												
4	−.14	−.09	−.08	+.03	−.16	−.23	−.18	−.08	−.45	−.42	−.18	−.18
5	−.18	−.13	−.15	−.02	−.19	−.26	−.23	−.15	−.55	−.49	−.34	−.22
6	−.17	−.18	−.18	−.07	.00	−.07	−.01	.00	−.56	−.56	−.37	−.20
7	−.21	−.21	−.11	+.22	+.22	+.12	+.21	+.27	−.25	−.53	−.37	−.21
8	−.17	−.17	−.01	+.30	+.25	+.26	+.34	+.43	+.14	−.24	−.29	−.22
9	−.12	−.07	+.09	+.24	+.18	+.24	+.38	+.44	+.38	+.12	−.10	−.13
10	−.01	+.01	+.12	+.09	+.04	+.10	+.32	+.27	+.42	+.28	+.07	−.01
11	+.05	+.06	+.09	−.12	−.10	−.10	+.09	+.02	+.19	+.33	+.22	+.08
12 p	+.10	+.06	+.03	−.20	−.15	−.30	−.18	−.24	+.04	+.22	+.24	+.09
1	+.13	+.06	−.04	−.26	−.30	−.29	−.28	−.24	−.14	+.25	+.28	+.09
2	+.13	+.06	−.11	−.35	−.26	−.32	−.33	−.57	−.22	+.24	+.24	+.15
3	+.18	+.05	−.13	−.37	−.36	−.35	−.43	−.63	−.33	+.25	+.27	+.20
4	+.19	+.08	−.14	−.41	−.39	−.27	−.43	−.64	−.15	+.27	+.34	+.22
5	+.21	+.12	−.10	−.40	−.33	−.08	−.34	−.48	+.11	+.29	+.29	+.15
6	+.18	+.09	+.01	−.22	−.22	−.10	−.26	−.14	+.32	+.40	+.17	+.14
7	+.12	+.13	+.09	+.01	+.12	+.24	+.09	+.18	+.38	+.29	+.10	+.13
8	+.07	+.10	+.13	+.16	+.24	+.39	+.31	+.24	+.33	+.19	+.07	+.08
9	+.03	+.10	+.12	+.24	+.29	+.39	+.25	+.27	+.27	+.11	+.02	+.06
10	−.05	+.04	+.09	+.25	+.47	+.32	+.21	+.24	+.18	+.01	−.05	.00
11	−.08	+.01	+.08	+.21	+.20	+.24	+.17	+.22	+.11	−.08	−.07	−.02
12	−.10	.00	+.08	+.23	+.17	+.18	+.14	+.16	−.02	−.19	−.17	−.02
Means...	5.33	5.21	5.15	6.07	7.59	10.10	11.44	11.20	9.99	7.99	6.29	5.43

TABLE 4.—*Diurnal variation of the vapor tension at Blue Hill, 195-meter level.*

Hours.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
12 a	+.85	+.71	+.75	+1.14	+.92	+1.12	+.75	+.95	+.40	+.69	+.50	+.45
1	+.72	+.62	+.67	+.94	+.87	+.80	+.56	+.40	+.39	+.39	+.48	+.45
2	+.49	+.52	+.47	+.75	+.78	+.13	+.55	−.10	+.11	+.22	+.42	+.43
3	+.33	+.36	+.33	+.47	+.65	−.04	+.24	−.30	−.17	+.05	+.34	+.34
4	+.14	+.26	+.21	+.21	+.19	−.11	+.10	−.43	−.44	−.06	+.11	+.27
5	+.04	+.06	+.03	+.15	−.08	−.16	−.01	−.49	−.71	−.24	−.03	+.12
6	−.08	−.10	−.10	−.06	−.33	−.47	−.21	−.74	−.94	−.43	−.16	.00
7	−.25	−.21	−.30	−.11	−.57	−.50	−.41	−.46	−1.07	−.60	−.36	−.10
8	−.31	−.35	−.37	−.29	−.46	−.24	−.57	−.56	−.93	−.59	−.45	−.19
9	−.43	−.47	−.56	−.23	−.46	−.31	−.69	−.41	−.49	−.52	−.42	−.23
10	−.46	−.51	−.57	−.32	−.37	+.05	−.34	−.02	+.03	−.40	−.27	−.28
11	−.52	−.49	−.59	−.29	−.39	−.14	−.11	+.28	+.26	−.13	−.12	−.22
12 p	−.51	−.54	−.56	−.38	−.33	+.22	+.41	+.59	+.46	−.10	−.04	−.28
1	−.50	−.48	−.56	−.46	−.37	−.29	+.37	+.53	+.55	+.03	−.01	−.33
2	−.49	−.43	−.46	−.65	−.43	−.01	+.28	+.68	−.55	+.03	−.07	−.30
3	−.49	−.34	−.41	−.67	−.35	−.08	−.11	+.22	+.33	+.09	−.17	−.30
4	−.47	−.27	−.20	−.60	−.37	−.25	−.20	+.19	+.11	−.01	−.34	−.29
5	−.38	−.22	−.14	−.58	−.33	−.46	−.45	−.16	+.06	−.02	−.24	−.25
6	−.23	−.19	−.09	−.66	−.42	−.24	−.66	−.17	+.17	−.04	−.28	−.20
7	−.12	−.06	−.01	−.48	−.37	−.41	−.63	−.48	+.11	−.06	−.28	−.17
8	+.04	−.03	+.09	−.39	−.05	−.45	−.55	−.26	−.08	−.03	−.21	−.12
9	+.34	+.22	+.32	+.06	−.02	−.10	+.05	−.10	+.17	+.10	−.10	+.06
10	+.54	+.47	+.60	+.46	+.41	+.33	+.12	+.05	+.26	+.34	+.04	+.18
11	+.79	+.58	+.65	+.87	+.79	+.52	+.79	+.60	+.34	+.46	+.16	+.37
12	+.85	+.71	+.75	+1.14	+.92	+1.12	+.75	+.95	+.40	+.69	+.50	+.45
Means...	2.06	2.13	2.63	3.78	6.39	9.49	12.37	11.76	8.69	4.76	3.29	2.16

TABLE 5.—*Diurnal variation of the vapor tension at Blue Hill, 400-meter level.*

Hours.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
12 a	+.13	+.06	+.01	−.09	+.10	−.46	−.11	−.19	+.20	+.22	+.12	+.13
1	+.14	.00	−.02	−.15	+.13	−.51	−.48	−.30	+.31	+.29	+.18	+.16
2	+.13	−.06	−.03	−.21	+.17	−.59	−.74	−.53	+.31	+.31	+.23	+.17
3	+.09	−.10	−.06	−.25	+.13	−.64	−1.01	−.70	+.26	+.31	+.25	+.17
4	−.01	−.14	−.08	−.31	+.10	−.73	−1.11	−.82	+.09	+.34	+.25	+.16
5	−.12	−.17	−.11	−.31	−.12	−.73	−1.11	−.93	−.07	+.09	+.13	+.07
6	−.19	−.19	−.15	−.31	−.32	−.73	−1.08	−.82	−.23	−.06	−.12	−.01
7	−.22	−.20	−.19	−.29	−.55	−.64	−1.01	−.70	−.45	−.18	−.19	−.10
8	−.22	−.22	−.21	−.22	−.64	−.46	−.74	−.53	−.49	−.29	−.23	−.15
9	−.20	−.20	−.17	−.15	−.65	−.28	−.52	−.36	−.49	−.29	−.21	−.16
10	−.15	−.15	−.10	−.03	−.48	−.05	−.30	+.01	−.28	−.24	−.12	−.16
11	−.06	−.03	−.02	+.10	−.15	+.29	−.05	+.26	−.01	−.09	−.07	−.16
12 p	+.06	+.11	+.11	+.27	+.10	+.59	+.27	+.48	+.43	+.03	−.02	−.15
1	+.13	+.17	+.20	+.47	+.35	+.95	+.48	+1.01	+.48	+.12	−.02	−.15
2	+.15	+.21	+.24	+.56	+.51	+1.11	+.74	+1.29	+.54	+.12	−.04	−.14
3	+.09	+.21	+.25	+.63	+.58	+1.44	+.89	+1.47	+.54	+.09	−.08	−.12
4	+.13	+.22	+.27	+.53	+.51	+1.49	+1.00	+1.24	+.41	+.03	−.12	−.10
5	+.08	+.20	+.24	+.34	+.35	+1.16	+1.07	+.80	+.22	−.09	−.12	−.07
6	+.03	+.14	+.17	+.25	+.17	+.64	+1.00	+.42	−.12	−.18	−.12	−.02
7	−.02	+.08	+.09	−.05	+.03	+.09	+.94	+.11	−.33	−.29	−.10	+.02
8	−.05	+.05	+.01	−.11	−.12	−.19	+.74	−.19	−.49	−.29	−.02	+.07
9	−.05	+.01	−.04	−.15	−.12	−.37	+.50	−.30	−.49	−.26	+.04	+.09
10	−.03	+.02	−.06	−.15	−.12	−.41	+.22	−.30	−.49	−.09	+.13	+.11
11	+.04	+.03	−.04	−.13	−.12	−.54	−.05	−.30	−.17	+.12	+.12	+.14
12	+.13	+.06	+.01	−.09	+.10	−.46	−.11	−.19	+.20	+.22	+.12	+.13
Means...	1.59	1.57	1.74	3.02	5.40	7.43	10.10	9.57	8.32	4.45	3.14	1.90

TABLE 6.—*Diurnal variation of the vapor tension at Blue Hill, 1000-meter level.*

Hours.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
12 a	+.21	+.12	+.16	+.06	+.09	−.31	−.15	+.21	+.26	+.34	.00	+.22
1	+.17	+.11	+.08	−.05	−.16	−.68	−.49	−.24	+.17	+.27	−.03	+.20
2	+.08	+.07	+.00	−.15	−.42	−.96	−.64	−.84	−.03	+.10	−.16	+.07
3	+.03	+.01	−.08	−.22	−.53	−1.22	−1.39	−1.28	−.31	−.09	−.39	−.06
4	−.09	−.04	−.09	−.26	−.67	−1.32	−1.64	−1.56	−.62	−.27	−.33	−.11
5	−.14	−.07	−.09	−.24	−.80	−1.32	−2.00	−1.60	−.87	−.42	−.44	−.17
6	−.17	−.09	−.03	−.20	−.74	−1.19	−1.84	−1.49	−.94	−.37	−.44	−.21
7	−.22	−.07	−.02	−.14	−.72	−.96	−1.55	−1.27	−.88	−.36	−.44	−.29
8	−.20	−.05	−.05	−.09	−.58	−.62	−1.29	−.90	−.78	−.36	−.29	−.26
9	−.16	−.07	−.09	−.10	−.43	−.27	−.95	−.53	−.48	−.27	−.13	−.20
10	−.15	−.07	−.10	−.06	−.09	+.04	−.37	−.10	−.18	−.21	+.04	−.14
11	−.15	−.08	−.15	+.02	+.04	+.44	+.06	+.28	+.14	−.08	+.10	−.09
12 p	−.16	−.09	−.16	+.07	+.20	+.61	+.49	+.63	+.46	+.06	+.19	−.05
1	−.14	−.09	−.10	+.07	+.38	+.94	+.74	+1.04	+.55	+.22	+.34	−.05
2	−.14	−.07	−.05	+.06	+.52	+1.21	+1.26	+1.22	+.95	+.22	+.32	−.03
3	−.11	−.04	−.01	+.07	+.51	+1.28	+1.51	+1.34	+.95	+.18	+.32	+.01
4	−.09	−.01	+.03	+.13	+.61	+1.37	+1.64	+1.21	+1.05	+.12	+.28	+.02
5	−.01	−.02	+.02	+.17	+.57	+1.24	+1.70	+1.09	+.65	+.03	+.20	+.05
6	+.09	−.01	+.03	+.14	+.51	+1.05	+1.70	+.85	+.56	+.03	+.15	+.06
7	+.19	+.01	+.01	+.12	+.43	+.71	+1.64	+.55	+.43	.00	+.10	+.11
8	+.23	+.05	+.06	+.14	+.37	+.43	+1.29	+.38	+.20	−.03	+.10	+.17
9	+.24	+.06	+.13	+.10	+.37	+.08	+.91	+.21	+.10	+.06	+.08	+.19
10	+.23	+.11	+.17	+.13	+.37	+.04	+.53	+.02	+.24	+.19	+.08	+.21
11	+.24	+.14	+.18	+.13	+.23	−.27	+.09	+.09	+.23	+.35	+.05	+.22
12	+.21	+.12	+.16	+.06	+.09	−.31	−.15	+.21	+.26	+.34	.00	+.22
Means...	1.37	1.32	1.73	2.82	4.66	5.94	8.73	8.15	6.42	4.37	2.91	1.82

TABLE 7.—*Diurnal variation of the atmospheric electric potential, Greenwich observations, on an arbitrary scale. Clear days.*

Hours.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
12 a	−1	−4	+4	+6	+4	+6	+5	+6	0	−1	−2	+2
1	−7	−7	−1	+2	0	+3	+3	+3	−5	−4	−7	−2
2	−9	−12	−7	−1	−3	+2	+1	+1	−10	−7	−6	−6
3	−11	−14	−9	−4	−6	0	−2	−2	−11	−9	−8	−11
4	−12	−14	−9	−5	−8	−2	−3	−4	−11	−10	−8	−14
5	−14	−13	−7	−2	−7	−2	−1	−4	−14	−12	−8	−14
6	−14	−12	−4	+2	−2	0	−3	−1	−13	−12	−6	−12
7	−9	−6	0	+9	+7	+4	+4	+1	−10	−12	−3	−9
8	−6	−4	+2	+11	+10	+1	+1	+1	−7	−13	−1	−7
9	−2	−1	+2	+5	+3	−2	+1	0	−2	−7	0	−3
10	+6	+8	+6	+8	+10	+3	+7	+6	+8	+1	+9	+2
11	+10	+7	+4	−3	+4	−2	+3	+3	+9	+5	+5	+9
12 p	+4	+1	−2	−9	−6	−5	−3	−2	+4	0	+3	+6
1	+4	−2	−5	−11	−8	−8	−7	−5	+1	+2	+2	+7
2	+4	−1	−7	−10	−9	−9	−10	−8	−1	+2	+2	+6
3	+6	+2	−8	−10	−9	−9	−8	−8	−1	+4	+3	+5
4	+7	+6	−10	−9	−5	−9	−6	−8	+1	+9	+4	+5
5	+7	+8	−3	−6	−1	−6	−5	−7	+7	+14	+6	+6
6	+8	+10	+2	−3	+1	−4	−3	−2	+11	+14	+6	+7
7	+7	+12	+8	0	0	−3	−2	+2	+13	+11	+4	+5
8	+7	+10	+11	+5	+1	−1	−1	+4	+12	+7	+3	+4
9	+6	+7	+10	+7	+7	+6	+5	+8	+9	+7	+4	+9
10	+5	+7	+10	+8	+10	+11	+9	+10	+6	+8	+5	+9
11	+2	+3	+5	+5	+6	+10	+7	+6	+3	+4	+2	+6
12	−5	−3	−2	−1	+2	+6	+4	+2	−4	+1	−2	+2
Means...	76	84	73	66	60	42	44	45	49	56	49	71

In my next paper I will show that this action, at the same time, produces the diurnal variation of the magnetic field as observed at the surface of the earth.

TABLE 8.—*Diurnal variation of the atmospheric electric potential; Greenwich observations; rainy and clear days.*

Hours.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
12a.	0	−2	+1	+4	+5	+7	+5	+6	−4	−1	0	+3
1	−7	−3	−2	+3	+2	+5	+3	+3	−3	−5	−3	−3
2	−9	−9	−5	−3	−3	0	−1	+3	−6	−6	−4	−10
3	−11	−10	−8	−5	−7	−1	−4	−1	−9	−8	−7	−13
4	−14	−12	−8	−6	−9	−4	−5	−3	−10	−10	−7	−14
5	−13	−12	−6	−7	−8	−3	−2	−3	−12	−11	−7	−14
6	−14	−10	−3	−5	−5	−1	−1	−2	−12	−12	−7	−12
7	−10	−6	+2	+2	+4	+1	+2	0	−9	−8	−5	−6
8	−8	−4	+6	+6	+6	−1	+2	0	−6	−7	−4	−2
9	−5	0	+2	+1	+4	−3	+1	−1	−1	−2	−3	+1
10	+5	+6	+6	−2	+4	+4	+9	+6	+6	+4	+2	+6
11	+8	+9	+2	−2	+2	−2	+5	+3	+7	+3	+3	+6
12p.	+4	+1	0	−6	−6	−2	0	+1	+2	−1	+2	+4
1	+6	0	0	−5	−8	−6	−6	−7	+1	0	+1	+1
2	+5	−1	−3	−2	−10	−8	−9	−6	−1	0	+1	+2
3	+6	+2	−2	−4	−6	−3	−8	−12	−1	+2	+3	+2
4	+8	+8	−4	−4	−2	−4	−6	−6	+1	+9	+3	+4
5	+5	+7	+2	−3	+1	−4	−7	−5	+5	+10	+3	+7
6	+8	+9	+7	+1	+1	−2	−1	+2	+9	+12	+4	+8
7	+10	+9	+8	+7	+6	+1	−2	+3	+10	+9	+5	+7
8	+6	+7	+5	+9	+3	+3	−2	+4	+8	+5	+4	+2
9	+4	+6	+6	+6	+9	+6	+6	+7	+6	+5	+3	+9
10	+5	+6	+5	+11	+12	+10	+10	+13	+6	+7	+4	+8
11	+4	+3	+2	+10	+11	+9	+9	+9	+3	+5	+2	+3
12	+1	−3	−1	+4	+5	+6	+6	+5	0	−2	−2	+2
Means...	62	68	62	56	52	37	42	39	44	47	43	53

TABLE 9.—*Annual variation of the atmospheric electric potential; Greenwich observations; on an arbitrary scale.*

Years.	All days.	Rainy days.	Clear days.	Factor.	All days.	Rainy days.	Clear days.
1881	262	....	....		524	....	....
1882	210	121	287		420	242	574
1883	264	152	340		528	304	680
1884	236	117	299		472	234	598
1885	234	85	328	× 2 =	468	170	656
1886	224	127	301		448	254	602
1887	305	176	388		610	352	776
1888	285	169	370		570	338	740
1889	....	....	....	....	....	....	....
1890	....	....	....	....	629	433	725
1891	....	....	....	....	542	376	670
1892	....	....	....	....	465	332	557
1893	....	....	....	....	553	421	663
1894	....	....	....	....	514	358	661
1895	....	....	....	....	761	623	880
1896	....	....	....	....	661	516	768
1897	....	....	....	....	586	459	679
1898	....	....	....	....	483	342	553
1899	....	....	....	....	343	184	432
1900	....	....	....	....	450	338	539
1901	....	....	....	....	593	417	680

THE OBSERVATIONS WITH KITES AT THE BLUE HILL OBSERVATORY, 1897-1902.

By Prof. FRANK H. BIGELOW.

In June, 1904, the Blue Hill Observatory published its observational data on the meteorological elements in the lower strata of the atmosphere, temperature, humidity, and wind vectors at various heights up to about 4000 meters, as derived from the kite ascensions made during the years 1897–1902, and in March, 1905, a discussion of these data by Mr. H. H. Clayton was distributed. These observations are greatly needed in American meteorology, and they constitute the first comparatively complete series of results that have been placed in the hands of students in the United States. In 1898 the U. S. Weather Bureau published in Bulletin F, compiled by Mr. H. C. Frankenfield, the results of the observations made during a six months campaign at sixteen stations in the Mississippi and Ohio valleys, besides one at Washington, D. C. These ascensions were made in the warm half of the year, May to October, and in the daytime, so that the resulting gradients are larger than can be accepted for the mean of the day and the mean of the year. Since the full problem requires the determination of the gradients for each hour of the day, and for each month in the year, in order that any application may be reliable in theoretical discussions of the circulation of the atmosphere, or in solar meteorology, those observations could not be extended to such questions. A practical handling of the Blue Hill data, comprising numerous ascensions at all hours of the day and night, and in all months during five years, shows that even this amount is very meager as compared with the demands of meteorology. As a valuable contribution, however, the Blue Hill observations are welcome to students, and I am very glad to express my obligations to those who have executed this laborious investigation. A careful examination of the data leads us to believe that the ascensions were skilfully conducted, and that the results are reliable up to the degree of precision at present attainable in that class of work. My own discussion of these data, of which an account is given in the MONTHLY WEATHER REVIEW for February, 1905, "The diurnal periods of the temperature," was executed in the interval between the appearance of the first and the second parts of the work, and, hence, the results obtained by me are independent of those published in the Blue Hill discussion. Since the general conclusions are in agreement, we may be confident that the observations bear the interpretation placed upon them by Mr. Clayton and by myself, and while the scope of the treatment is different in the two cases, since I had questions of cosmical meteorology in mind, there is no important divergence in the principal results. I have sought, in my treatment of the observations, to avoid composite curves of the gradients, by discussing the data for each month of the year, as explained in my paper, intending to gain thereby a working program for the organization of the Mount Weather Observatory, and for the correlation of several outstanding problems in barometry, ionization, and magnetism of the atmosphere. As Mr. Ward has given a suitable summary of Mr. Clayton's results in Science, March 17, 1905, and as the report of my conclusions may be found in the series of papers in the MONTHLY WEATHER REVIEW, February to July, 1905, "Studies on the diurnal periods of the lower strata of the atmosphere," it is not necessary to repeat those remarks in this connection. It will be proper, however, to make some suggestions arising from these studies, with a view to their application in work of a similar kind upon the meteorological elements in the lower strata of the atmosphere.

(1) *Mixed systems of data.*—Great trouble is certain to result in meteorological studies from the indiscriminate employment of the metric system, the English system, or the English and metric systems combined. The European data are usually in the metric system, the English and the American data are generally in the English systems, but the Blue Hill data are given in a mixed system—height in meters, wind velocity in meters per second, and temperature in degrees Fahrenheit. To translate these three classes of data across from one system to the other, as is required in every cosmical investigation, adds such labor to the work as to make the difficulty of executing the research much greater than it ought to be. Obviously, we can not approve of introducing mixed systems of data into meteorology, while so much effort is being made to reduce the two primitive systems to a single system.

(2) *Gradients referred to a summit station.*—It is evident that the summits of hills or mountains offer great advantages in mechanical kite flights, over valley or low-level stations, because the prevailing winds are fresher, and this facilitates the starting of an ascension. Also, the elevated sites are somewhat freer of the irregular gusts which prevail in the surface stratum within a few hundred feet of the ground. Yet, with this advantage, there is introduced, on the other hand, an increase in the scientific complexity in handling the observed data, because the gradients in the lowest strata are very unequal, as between day and night, or from one month to another, so that the temperature-falls, or the temperature gradients referred to the summit, can not be taken as equivalent to those in the free air over a great plain, without very careful corrections. All general gradients must be corrected for the hour of the day and to a low-level surface, or the plain country, before they can be introduced into the equations of cyclones

and anticyclones. Thus, one can see by referring to my charts 14–25 in the MONTHLY WEATHER REVIEW of February, 1905, that the mean daily gradients can be found only by taking the daily means at the several levels and computing the gradients from them. Gradients referred to the summit of Blue Hill, 195 meters, will be very different from those referred to the Valley Station, 15 meters, and the gradients will differ greatly for the same day, according to the hour to which the observations refer. Much of the divergence in the published gradient data from the several countries is due to an omission to apply these principles. In the case of the Blue Hill data, the record for the Valley Station was usually published only for the beginning and the ending of a kite flight, and it was not possible to accurately interpolate the intermediate values from the report. These temperature data were courteously supplied by the observatory to the Weather Bureau by a special arrangement.

Applying these considerations to the Mount Weather Observatory, it is evident that the summit station must be supplemented by self-registering instruments at the low levels, in the Piedmont country at Trapp and Leesburg and in the Shenandoah Valley at Berryville, Winchester, and Front Royal. There is certain to be a dynamic heating and cooling effect as the wind sweeps over the summit of the Blue Ridge Mountains, and the local action of the currents must be carefully investigated. Furthermore, there is much danger of failing to deduce the correct values of the gradients from the balloon ascensions unless the temperatures at the level of the country beneath them from Bluemont to Washington and Baltimore can be secured, and unless the balloons are sent up in about equal numbers at all hours of the day and night. It is necessary to eliminate all the local conditions and the ordinary hourly variations before anything like accurate general temperature gradients can be computed.

(3) *The height of the diurnal convectional disturbances.*—Mr. Clayton seems to have assigned 2000 meters as the height at which the diurnal variation of the temperature becomes insensible, but by reference to Table XIII of his report, it is seen that the gradients in the successive 500-meter levels do not become constant for each month, as between the day and night values given in the first and second sections of the table, till the 2500–3000 stratum is passed. It has been my experience that the vertical gradients on the New England coast are generally smaller than they are in the middle valleys of the continent, and I am of the opinion that the diurnal convection reaches about the two-mile limit in many regions of the United States. Consequently, I have adopted that elevation as the limit in order to secure a system of gradients somewhat more applicable to the entire country than those strictly limited to the Blue Hill district could be supposed to represent.

(4) *The inversion of temperatures.*—One of the valuable facts brought out in these discussions is concerned with the diurnal inversion of temperatures in the lower strata. Except in midsummer when the air is warmed up to great heights, and the ground does not cool so rapidly during the night, there is a complete inversion between the surface temperature and the air temperature at a few hundred meters above the ground, throughout the day and night, except at the hours of transition, 8 a. m. and 8 p. m., approximately. These air conditions are the results of two movements, (1) the vertical convection over a station, and (2) the horizontal movement of the cone of temperature-fall, which is very rapid from east to west with the earth's rotation. Generally the rising warm air of the day falls back to the ground outside this cone, that is during the night, and this makes a complete inversion between the day and night throughout the 24 hours. The cold temperature by day, in the air above the warm ground, consists really of the cold night air of the preceding day, and the warm air by night over the cold surface is the warm air of the preceding day lagging behind in its ascensional and its descensional path. The semidiurnal temperature curve, however, exhibits the influence of the surface heating and cooling when the convectional currents become vigorous through short distances in elevation. These remarks may be regarded as supplementary to those contained in the Blue Hill discussion of the observations.

It will be seen that these Blue Hill kite observations are unusually fruitful and valuable in many meteorological studies, and we sincerely hope that the series may be extended to several more years, and that other observatories will add further important data of a similar kind.

MATHEMATICAL THEORY OF THE NOCTURNAL COOLING OF THE ATMOSPHERE.

By S. TETSU TAMURA.

I. HISTORICAL AND CRITICAL SURVEY OF THE PROBLEM OF THE NOCTURNAL COOLING OF THE ATMOSPHERE.

The problem of the cooling of the atmosphere belongs to the group of the most important, yet extremely difficult, problems in meteorology. The variation of atmospheric temperature, for instance, depends not solely upon the solar radiation, which varies with the sun's altitude and the degree of sunshine or cloudiness, but, as shown by Fourier, Poisson, Pouillet, Melloni, and others, it also depends upon the influence of the emission by the earth's surface, that is, by the soil, vegetation, snow, and ocean. Even as to the air itself, we have to distinguish the radiating power of the dry air, clouds, haze, and dust.

If the lower strata of the air are heated by the solar rays and the emission by the earth's surface, the heated air tends to rise. This results very soon in tremulous and flickering streams, which collect into larger ones. Thus the propagation of heat goes on with relative rapidity by the process of convection. The conduction of heat from the earth's surface to the atmosphere also exists, though it operates very slowly. At the same time, a portion of the heat thus communicated is lost by a process of atmospheric radiation into sidereal space. Again, the influence of the winds and rain upon the atmospheric temperature is by no means negligible. Thus, it appears that it is impossible for us, at least in the present state of our knowledge, to solve the problem by the light of modern mathematical analysis; for even the world's greatest mathematicians of the last century failed to solve the problem analytically and left to us the so-called Bessel's interpolation[1] formula expressed by Fourier's series, which has been criticized by Wild and Angot as too far from representing nature.

If, however, we have to deal with the problem of the nocturnal cooling of the atmosphere, or of the cooling of the calm atmosphere during long arctic nights, our problem becomes a great deal simpler. At night the earth's surface is cooled by its emission of heat into space, and the temperatures of the lower layers of the air fall, and they thus become heavier. Therefore convective movements cease to a great extent. Other disturbances also are comparatively small during the nighttime. Consequently we may consider the nocturnal cooling of the atmosphere as dependent only upon radiation and conduction of heat between the atmospheric strata and the earth's surface.

One of the first who observed the cooling of bodies exposed during the night in the open field, under a clear sky and calm atmosphere, was Patrick Wilson, of Glasgow. His observations[2] were made about 1783 by means of two thermometers, one placed on the snow, the other freely suspended at the

[1]This formula is

$$\theta = \theta_m + A_1 \sin\left(\frac{2\pi}{T} t + \phi_1\right) + A_2 \sin\left(\frac{2\pi}{T} 2t + \phi_2\right) + \ldots\ldots$$

where T = periodic time, expressed in terms of hours.
θ_m = mean temperature of the day.
t = time reckoned in hours.
$A_1, A_2, A_3, \phi_1, \phi_2, \phi$, etc., are constants.

[2] Edinburgh Phil. Trans. Vol. I, p. 153.

height of four feet. On one of these nights the lower thermometer, under a perfectly clear sky, marked —21.7° F., while the other marked —15.0° F. The difference of six degrees diminished rapidly when clouds appeared on the horizon and entirely vanished when the sky was completely covered; the two thermometers had then the same reading, —13.7° F. Wilson was also the first to show that the effect of the radiation of bodies toward the sky is sensibly the same at all temperatures; so that in nights equally calm and serene the same substance is always cooled to the same extent, whatever may be the temperature of the atmosphere.

Some years later Six[3] found that a thermometer placed on the grass of a meadow during calm and clear nights continued several degrees lower than another perfectly similar thermometer suspended at the height of five or six feet, the difference between the two amounting sometimes to 7.5° F.

At the beginning of the nineteenth century, Wells[4] performed a long series of experiments on the nocturnal cooling of bodies, by placing thermometers in contact with the ground and leaves of plants, or by enveloping them with wool, cotton, and other substances. These thermometers, placed at a small distance from the earth's surface, gave a fall of 4.5° F. and even 7.8° F. below a thermometer without any envelope suspended at the height of four feet.

The experiments of Wells were repeated by many observers and notably by M. Pouillet[5]. He inserted one of the thermometers into swans-down contained in a vessel placed on the ground and left the other thermometer at the height of four feet. The lower thermometer, on certain nights, fell 8° or 9° F. below the upper one.

In 1847 M. Melloni read to the Royal Academy of Sciences at Naples a memoir[6] on the nocturnal cooling of bodies exposed to a free atmosphere in calm and serene weather and on the resulting phenomena near the earth's surface. This interesting paper tells us that Melloni, on some September nights of 1846, in the valley named La Lava, situated between the cities of Naples and Salerno, attempted to compare the radiation of lampblack, metals, and other substances, such as sawdust, leaves, and vegetable earths, exposed to the nocturnal influence of a serene sky. He came to the conclusion that the cooling of a black thermometer is owing to radiation, and not to the contact of the external air, and that the radiation of a metallic thermometer is so feeble as to escape direct observation, and also that the emissivity of the earth and vegetable substances did not seem to differ much from that of lampblack. He also convinced himself of the fact observed by Wilson, that a body exposed during the night to the influence of a sky of equal clearness and calmness is always cooled to the same extent, whatever may be the temperature of the air.

All these investigations on the nocturnal cooling of bodies, which are directly related to the problem of nocturnal cooling of the atmosphere itself, have, however, been purely observational. For the first formula of nocturnal cooling we are indebted to Johann Heinrich Lambert, of the Academy of Berlin. In the latter part of the eighteenth century he published his celebrated work "Pyrometrie," and in it he has given the following formula:[7]

$$\theta = \theta_1 + Ab^t \qquad (1)$$

in which θ_1 is the temperature of an enclosure and t the time. A and b are constants. This formula is called the Logarithmic Law of Cooling.

Prof. A. Weilenmann, of Zurich, applied Lambert's formula to the study of the variations of atmospheric temperatures at eight different places, and found that the value of b is almost constant for different localities, viz, (0.86—0.88). M. Alfred Angot,[8] of Paris, computed the value of b for all months of the year from the observational data of the nocturnal temperature at Paris. He found the mean value of b=0.87 for clear days and b=0.86 for cloudy days. Angot adopted 0.869 as the general mean of the values of b, and transformed Lambert's formula into the following form:

$$\theta=\theta_1+A\times 0.869^t \qquad (2)$$

in which $t=0$ is for sunset.

$$\theta=\theta_1+A\times 0.869^t=\theta_1+A(e^{-.143})^t$$
$$=\theta_1+A\,e^{-.143t}.$$

For $t=\infty$, $e^{-.143t}=0$ and $\theta=\theta_1$, and for $t=0$, $A=\theta_0-\theta_1$ where θ_0 is its initial temperature. Therefore, Lambert's formula takes the form,

$$\theta=\theta_1+(\theta_0-\theta_1)\,e^{-.143t}. \qquad (3)$$

Differentiating this formula, we have for the rate of nocturnal cooling,

$$\frac{\partial\theta}{\partial t}=Ab^t\log b=-.1405\times A\times 0.869^t$$

or

$$\frac{\partial\theta}{\partial t}=-.143\,(\theta_0-\theta_1)\,e^{-.143t}. \qquad (4)$$

In 1872 Weilenmann introduced in his memoir,[9] "Ueber den täglichen Gang der Temperatur in Bern," the following differential equations:

$$\frac{\partial\theta}{\partial t}=-h(\theta-\theta'_{x=0}) \qquad (5)$$

$$\left[\frac{\partial\theta'}{\partial t}\right]_{x=0}=-h(\theta'_{x=0}-\theta_1)+h(\theta-\theta'_{x=0}) \qquad (6)$$

where θ is the temperature of the air, $\theta'_{x=0}$ that of the earth's surface, θ_1 that of an imaginary upper stratum toward which the radiation of the earth's surface is supposed to take place, and h the emissivity of the earth's surface. Solving (5) and (6) simultaneously, Weilenmann found that, taking θ_1 as constant,

$$\theta=\theta_1+c_1e^{-0.382ht}+c_2e^{-2.618ht}. \qquad (7)$$

Then he computed the value of c_2 by applying the above formula to his observational data, and found that it is a very small number. Therefore the formula (7) reduces to the final equation,

$$\theta=\theta_1+c_1e^{-0.382ht} \qquad (8)$$

which is identical with Lambert's formula, for Weilenmann

[3] Six's Posthumous Works. Canterbury. 1794.

[4] Ann. de Chimie et de Physique. Third series. Vol. V.

[5] Pouillet, Éléments de Physique. Fourth edition, p. 610. 1844.

[6] Annales de Chimie et de Physique, 1848.

[7] For the sake of convenience, I shall use hereafter the following uniform notations:

	For atmosphere.	*For earth.*	
Temperature	θ	θ'	
Temperature of lowest stratum	$\theta_{x=0}$	$\theta'_{x=0}$	temperature of earth's surface.
Initial temperature	θ_0	θ'_0	
Emissivity or coefficient of radiation	σ	σ'	
Conductivity	k	k'	
Diffusivity	$\frac{k}{\rho c}=a^2$	$a'^2=\frac{k'}{\rho' c'}$	
Density	ρ	ρ'	
Specific heat	c	c'	
	$\frac{\sigma}{\rho c}=b^2$	$b'^2=\frac{\sigma'}{\rho' c'}$	

x = height of the stratum of invariable temperature in the air,
x' = depth of the stratum of invariable temperature in the earth.
θ_1 = temperature of imaginary athermanous stratum = sidereal temperature + upper atmospheric temperature.
θ_0 = initial temperature.
θ_m = mean temperature.
θ_{max} = maximum temperature.
θ_{min} = minimum temperature.
v = excess of temperature.
= time.

[8] "Influence de la Nébulosité sur la Variation diurne de la Temperature de Paris." Annales du Bureau Central, 1888.

[9] Schweizerische Meteorologische Beobachtungen, Bd. IX, 1872.

adopted .375 for the value of h. In his memoir he has finally shown how very closely his formula represents the natural phenomena of the nocturnal cooling of the atmosphere at Bern.

In the very beginning of his analysis, however, Weilenmann introduced a serious error by using the same coefficient h throughout in (5) and (6). In (5) h is evidently identical with $\frac{\sigma}{\rho c}$ in our notation, where σ is the coefficient of radiation of the atmosphere, ρ the density of the air, and c its specific heat. In the formula (6), however, h means $\frac{\sigma'}{\rho' c'}$ where σ' is the emissivity of the earth's surface. Hence, we see at once that h in (5) and in (6) can not be the same.

The problem was next attacked by Samuel Haughton, the Irish clergyman and scientist. In 1881 he published in the Transactions of the Royal Irish Academy two noteworthy papers under one title, "New Researches on Sun-heat and Terrestrial Radiation and on Geological Climates". In the first paper he treated the problem of the solar insolation and atmospheric radiation, adopting Rosetti's law of cooling[10]. The second paper has a direct connection with our problem. Empirically he came to the conclusion that at a temperature not much above θ_1 radiation is proportional to $\theta-\theta_1$; but at a temperature very much higher than θ_1 radiation increases faster than this difference, and may be best represented by a parabolic curve, having its axis vertical and its vertex at the origin, viz:

$$p\,\frac{\partial \theta}{\partial t} = (\theta-\theta_1)^n, \tag{9}$$

where $n = 2.04$ and $p = 4.25$ for the month of January, which values were obtained from the mean of the 35 years of observation. He also reached the conclusion that nocturnal cooling is well represented by Newton's law. In this paper, however, Haughton adopted for the value of θ_1 the lowest atmospheric temperature θ_{min} just before sunrise, because he thought that radiation must cease at that time. It appears that he followed the following argument:

$$\frac{\partial \theta}{\partial t} = K(\theta-\theta_1), \tag{10}$$

where K is a constant.

When θ becomes a minimum,

$$\frac{\partial \theta}{\partial t} = 0,$$

whence

$$K(\theta_{min}-\theta_1) = 0,$$

or

$$\theta_{min} = \theta_1.$$

But the integral curve of (10) is logarithmic and has no maximum or minimum point. Therefore, there is no point at which

$$\theta_1 = \theta_{min}.$$

In 1884, Prof. William Ferrel, the first and the greatest theoretical meteorologist, published a memoir[11] on "The Temperature of the Atmosphere and the Earth's Surface" and later introduced it into his "Recent Advances in Meteorology". In them he treated the problem of the nocturnal cooling of the earth's surface and of bodies near it. Applying Petit and Dulong's law of cooling to his analysis, Ferrel obtained for the nocturnal cooling of the earth's surface the following formula:

$$\mu^{\theta'_{x=0}-\theta_a} = \mu^{\theta_a-\theta_1} - \frac{1}{B\sigma'\mu^{\theta_a}}\cdot\frac{dQ}{dt} \tag{11}$$

where

$\theta'_{x=0}$ = temperature of the earth's surface.

θ_a = temperature of atmosphere at 4 feet above the earth's surface.

θ_1 = mean sky temperature, viz, the temperature of the imaginary athermanous stratum.

μ = 1.0077 one of Petit and Dulong's constants.

σ' = emissivity of the earth's surface.

B = rate at which heat is radiated from a unit surface of maximum emissivity, or of lampblack.

The expression $\frac{\partial Q}{\partial t}$ is the rate at which a unit of earth's surface is losing heat. According to this formula, $\frac{\partial Q}{\partial t}$ at first is comparatively large, but it gradually becomes less as the upper strata of the earth cool, but it never entirely vanishes. Therefore $\theta_a-\theta_1$ is the theoretical limit, to which $\theta'_{x=0}-\theta_a$ approximates, but can never quite reach, as $\frac{\partial Q}{\partial t}$ becomes smaller. This applies to the nocturnal cooling of the earth's surface, but it is to be regretted that Ferrel never touched the problem of the nocturnal cooling of the atmosphere itself.

Perhaps the most valuable contribution to our subject was made by Dr. Jules Maurer, of Zurich. Some twelve years after his countryman, A. Weilenmann, published his paper, Maurer dealt with the problem in a more analytical manner, and published the two important papers bearing the titles "Ueber die theoretische Darstellung des Temperaturgangs während der Nachtstunden and die Grösse der von der Atmosphäre ausgestrahlten Wärmemenge"[12] and "Temperaturleitung und Strahlung der ruhenden Atmosphäre"[13]. The first paper offers us some valuable formulæ and data; in particular he was the first to give us an approximate value of the coefficient of radiation by a cubic centimeter of air, which amounts to $.007 \times 10^{-4}$ cals. per minute. This Maurer deduced from the ordinary meteorological observations of the temperature of the atmosphere at nighttime, as given by the ordinary screened thermometers. Maurer finds indications that this coefficient is larger in summer and smaller in winter.

My careful examination of Doctor Maurer's memoirs, however, has revealed to me that he committed a serious mistake in his attempt to deduce an analytical formula for nocturnal temperature. He took advantage of Weilenmann's first equation

$$\frac{\partial \theta}{\partial t} = -\frac{\sigma}{\rho c}(\theta - \theta'_{x=0})$$

with which he deduced the formula,

$$\theta = \theta_1 + c_1 e^{-a_1 t} + c_2 e^{-a_2 t} \tag{12}$$

where c_1 and c_2, a_1 and a_2 are constants; a_2 is a function of ω_1 which is the first root of

$$\frac{\sigma'}{k'}\tan\omega + \omega = 0, \tag{13}$$

where ε' is a depth below the earth's surface at which diurnal heat waves are supposed to vanish.

But if we refer to Riemann-Weber's Partielle Differentialgleichungen, Bd. II, § 52, we can at once see that this transcendental equation was obtained by Maurer from Fourier's surface condition for secular cooling:

$$\left[k'\frac{\partial u'}{\partial x}\right]_{x=0} = \sigma' u'$$

[10] This law is expressed by the formula $\frac{\partial \theta}{\partial t} = (\theta-\theta_1)(a\Theta^2-\beta)$. Θ = absolute temperature; a and β are constants, and β is very small. From this Haughton deduced $\frac{\partial \theta}{\partial t} = -B(\theta+460)^3$, where θ and Θ are expressed in degrees Fahrenheit.

[11] Professional Papers of Signal Service No. XII.

[12] Annalen der Schweiz. Meteorologischen Centralanstalt, Band XXII. 1885.

[13] Meteorologische Zeitschrift, 1886.

or

$$\left[k' \frac{\partial \theta'}{\partial x} \right]_{x=0} = \sigma' (\theta'_{x=0} - \theta_{x=0}). \qquad (14)$$

This surface condition presupposes that $\theta_{x=0}$ the temperature of the lowest strata of the atmosphere is constant, and that all heat conducted from the interior of the ground upward is radiated immediately by the surface that is exposed to the air of constant temperature. Hence, Maurer's solution can not be true and can not accord with the actual conditions of the problem. In his second paper[14] Maurer introduced an erroneous integral of the general differential equation[15] for heat conduction and radiation,

$$\frac{\partial u}{\partial t} = \frac{k}{\rho c} \frac{\partial^2 u}{\partial x^2} - \frac{\sigma}{\rho c} u \qquad (15)$$

where $u = \theta - \theta_1$, and σ is the coefficient of radiation.

Another important paper[16] on the subject was published in 1892 by Dr. W. Trabert, formerly of Vienna and now professor in Innsbruck. The interesting feature of this paper is the extensive computation of the value of Weilenmann's b for 42 stations of different localities and different elevations, and he found the value of σ to be $.0077 \times 10^{-5}$, which is very near that of Maurer. Further, he has drawn the conclusion that the value of σ is independent of the temperature and density of the air, and that the radiation of a unit mass of air is simply proportional to the absolute temperature.

In 1900, Dr. K. Nakamura, Director of the Central Meteorological Observatory of Tokio, read to the International Congress of Meteorology in Paris a short paper entitled "Sur la March Diurne de la Temperature de l'Air". The chief feature of this paper was an attempt to represent diurnal temperature by a formula advanced by the author. His equation for the nocturnal cooling is—

$$\frac{\partial \theta}{\partial t} = - \frac{\sigma}{\rho c} (\theta - \theta_j - p \sin t - q \cos t). \qquad (16)$$

Preceiving that θ_1 in Newton's formula is not constant, Professor Nakamura substituted for it in Newton's law the expression $\theta_j - p \sin t - q \cos t$, where θ_j, p, and q are constants. The expressions $\sin t$ and $\cos t$ are, however, open to criticism, since it is impossible to take the sine and cosine of a time. Therefore, t must be multiplied by such coefficients as will transform t into an angle.

It will be of some interest here to mention von Bezold's important memoir[17] on the heat exchange at the earth's surface and in the air. The ground accumulates solar heat in summer, and gradually loses the stored energy in winter, so that there is a heat exchange during the year. A similar process occurs during the day and nighttime. According to von Bezold the heat content of the soil per unit area down to the depth ε of uniform temperature is

$$\int_0^{\varepsilon'} c\,(\theta' - \theta_0')\, dx$$

where θ_0' is the initial temperature and θ' the momentary temperature at the depth of x and c the heat capacity. ε' is the depth of the invariable stratum. The difference of the maximum and minimum values of the above integral is the amount of heat exchange. Dr. J. Schubert[18] extended von Bezold's idea still further. He applied the above principle to the heat exchange in the atmosphere and on the ocean. For the atmosphere the heat content is

$$\int_0^{\varepsilon} \rho\, c_p (\theta - \theta_0)\, dx$$

or introducing air pressure b

$$1.36\, c \int_{b_0}^{760} (\theta - \theta_0)\, db.$$

To this is to be added

$$0.6 \times 1.36 \int_0^{760} (e - e_0)\, db$$

where ε is the height of the stratum of invariable temperature in the atmosphere and e is the specific humidity of air. Schubert deduced the annual heat exchange in sandy soils, atmosphere, sea water, etc., and considered the effect of the earth's surface and ocean upon the temperature of the atmosphere. It will be interesting to apply these formulæ, or improved ones, if such be possible, to the study of daily heat exchange in the earth's surface and atmosphere.

Finally, I shall here add the titles of some memoirs and articles that bear some relation to our subject.

Fourier, Théorie Analytique de la Chaleur.

Poisson, Théorie Mathématique de la Chaleur. 1835.

Poisson, Mémoire sur les Température de la Partie solide du globe, de l'Atmosphere, etc. 1837.

Edmond Becquerel et Henri Becquerel, Mémoire sur la Température de l'Air a la Surface du Soil, etc. 1879.

J. Glaisher, On the Radiation of Heat at Night, from the Earth, etc. 1847.

H. Hennessy, On the Distribution of Temperature in the Lower Region of the Earth's Surface. 1867.

H. Wild, Ueber die Bodentemperatur in St. Petersburg und Nukuss. 1878.

H. Wild, Die Differenzen der Bodentemperatur, etc. St. Petersburg, 1897.

C. C. Hutchins, Radiation of Atmospheric Air. Am. Jour. Sci., Vol. XLIII, 1892.

Cleveland Abbe, Atmospheric Radiation of Heat and its Importance in Meteorology. Am. Jour. Sci., Vol. XLIII, 1892.

Frank Very, Atmospheric Radiation. Weather Bureau Bulletin. 1900.

Paul Campan, Essai sur le Refroidissant de l'Air et sur les Lois du Rayonnement. 1902.

H. A. Watson, Convection of Heat. Cambridge Phil. Soc. Proc. April, 1904.

C. C. Hutchins and J. C. Pearson, Air Radiation. Monthly Weather Review. July, 1904.

II. A MATHEMATICAL THEORY OF THE NOCTURNAL COOLING OF THE ATMOSPHERE NEAR THE EARTH'S SURFACE.

Hermann von Helmholtz attempted to prove in his famous memoir[19] "Ueber Atmosphärische Bewegungen" that by means of continually effective forces, there are formed in the atmosphere surfaces of discontinuity; that is to say, atmospheric strata of different density and temperature can lie contiguous, one above another, with a well defined surface of discontinuity between them. Recent meteorologists appear to reach the same conclusion by their balloon observations and kite experiments. In my mathematical analysis, however, I assume that the calm atmosphere is composed of an infinite number of very thin layers parallel to the earth's surface, that each stratum possesses the same temperature throughout, and that heat conduction, and radiation take place in one dimension only, viz, vertically.

Then the general equation for the nocturnal cooling of the atmosphere may be written as follows:

$$\frac{\partial \theta}{\partial t} = \frac{k}{\rho c} \frac{\partial^2 \theta}{\partial x^2} - \frac{\sigma}{\rho c} (\theta - \theta_1),$$

[14] Meteorologische Zeitschrift, 1886.

[15] This differential equation and Maurer's second paper will be discussed later.

[16] Der tägliche gang der Temperatur und des Sonnenscheine auf dem Sonnblickgipfel. Denkschriften der Wien Acad. Bd LIX.

[17] "Der Wärmeaustausch an der Erdoberfläche und in der Atmosphäre." Sitzb. der kgl. preuss. Acad. d. Wiss. Berlin, 1892.

[18] "Der Wärmeaustausch in festen Erdboden, in Gewässern u. in der Atmosphäre. 1904.

[19] Sitzb. der kgl. preuss. Akad. d. Wiss. 1888. Also translated by Abbe. Smithsonian Institution. 1891.

or $$\frac{\partial\theta}{\partial t}=a^2\frac{\partial^2\theta}{\partial x^2}-b^2(\theta-\theta_1). \qquad (1)$$

In addition to this there are two boundary conditions:

(a) For $x=0$, or at the earth's surface, θ is directly influenced by the temperature of the earth's surface; $\theta=f(\theta')$ or there may be formed some equation like Fourier's surface condition.

(b) For $x=\varepsilon$, or at the stratum of invariable temperature, say 30 metres (after Wild), $\frac{\partial\theta}{\partial t}=0$.

In integrating the differential equation (1) there are at least two difficulties. The first is that we do not know what functional relation exists between $\theta_{x=0}$ and $\theta'_{x=0}$. The second difficulty lies in our ignorance of the temperature gradient in the air or the nature of the function $\theta=f(x)$, when $t=0$.

Maurer and Helmholtz have shown us how extremely insignificant is the effect of heat conduction upon the temperature of the atmosphere. Assuming that the temperature of the lowest stratum of the atmosphere is of simple harmonic type, Maurer used a particular solution of the differential equation

$$\frac{\partial\theta}{\partial t}=a^2\frac{\partial^2\theta}{\partial x^2} \qquad (2)$$

namely

$$\theta=Ae^{-px}\cos\left(\frac{2\pi t}{T}-px+q\right), \qquad (3)$$

where T is the period of temperature variation and A its amplitude. Substituting (3) for θ in equation (2), we obtain

$$p=\sqrt{\frac{\pi}{a^2T}}.$$

Hence the rate v at which heat is propagated from one stratum to another must be

$$v=\frac{2\pi}{pT}=2a\sqrt{\frac{\pi}{T}}. \qquad (4)$$

Then Maurer took twelve hours of nighttime as a unit and for a^2 adopted Stefan's value,[20] which is 0.18 for one second. Hence for the half day, we have

$$a^2=0.18\times60\times60\times12 \text{ (gram.}\times\text{cm.}^{-1}\times\tfrac{1}{2}\text{ day}^{-1}).$$

Therefore the rate of heat conduction

$$v=2\sqrt{\pi\times0.18\times60\times60\times12}=3.1 \text{ meters in twelve hours.} \qquad (5)$$

Hence Maurer concluded that at this distance above the earth's surface heat waves disappear if the amplitude of heat waves at the surface does not exceed 10° or 20° and that the influence of nocturnal cooling of the earth's surface upon the temperature of air that is not very near to the earth's surface is inappreciable, so far as heat conduction is concerned.

Let us now integrate the equation (2) for thermal conduction of the atmosphere in one dimension,

$$\frac{\partial\theta}{\partial t}=a^2\frac{\partial^2\theta}{\partial x^2} \qquad (6)$$

under the two conditions

(a).... $\theta=0$, for $x=0$, or the temperature of air on the earth's surface is 0°.

(b) .. $\frac{\partial\theta}{\partial x}=0$, for $x=H$, or the vertical gradient of temperature is zero at upper boundary surface of the atmosphere.

A particular solution, which satisfies (a), is

$$\theta=Ae^{-a^2\alpha^2t}\sin(\alpha x).$$

In order that this solution may satisfy (b) also, we must have

$$\theta=Ae^{-a^2\frac{\pi^2}{4H^2}t}\sin\left(\frac{\pi}{2H}x\right).$$

whence for $t=0$,

$$\theta_0=A\sin\left(\frac{\pi}{2H}x\right).$$

In order that $e^{-a^2\frac{\pi^2}{4H^2}t}$ may be equal to $\frac{1}{2}$, we must have

$$\frac{a^2\pi^2}{4H^2}t=\log_e 2=0.6932,$$

whence $$t=\frac{0.6932\times4H^2}{a^2\pi^2}=0.2809\frac{H^2}{a^2}$$

Adopting Maxwell's value for a^2 and 8000 meters for H, we reach the result,

$$t=36{,}000 \text{ years (approximately)},$$

That is to say,

$$\theta=A\sin\left(\frac{\pi}{2H}x\right) \text{ for } t=0. \qquad (7)$$

$$\theta=\tfrac{1}{2}A\sin\left(\frac{\pi}{2H}x\right) \text{ for } t=36{,}000 \text{ years.}$$

From this it follows that an interval of 36,000 years would be necessary in order by conduction to reduce, by one-half, the difference of temperature between the bottom and top of the atmosphere. This is the conclusion reached by Helmholtz. In the above analysis, however, we must remember that we assumed that the temperature of the atmospheric stratum adjacent to the earth's surface is always equal to 0°, the temperature gradient $\frac{\partial\theta}{\partial x}=0$ at $x=H=8000$ meters, and that the whole atmosphere is of uniform density, $a^2=\frac{k}{\rho c}$ being taken as constant. Therefore, Helmholtz's conclusion may not apply strictly, but it shows that the effect of heat conduction upon the temperature of the atmosphere is extremely insignificant, except near the earth's surface. On the other hand there are indications that Maurer's estimate of the effect of heat conduction is too large. He supposed that the variation of the atmospheric temperature very near the earth's surface is of simple harmonic nature and also that during the nighttime heat is propagated only by conduction. Radiation was not taken into account. Therefore, if we take account of atmospheric radiation, heat waves can not reach as high as three meters, but must die away long before they reach that height.

Doctor Wells gives us some very interesting information[21] on the formation of ice in India on nights when the air does not fall to the freezing point. Square pits about two feet deep and 30 inches wide were formed and filled with straw to a depth of about eight inches or one foot. On this rows of small unglazed earthen pans were placed, about $1\frac{1}{4}$ inches deep, filled with boiled soft water. Evaporation and radiation, acting together, cooled the water below freezing, and ice was formed. The natives of Bengal manufacture ice in large quantities by the practise of this method,[22] even when the temperature of the air is 16° to 20° F. above the freezing point. Doctor Wells pointed out that as the formation was most successful on calm, clear nights, the effect was due chiefly to radiation. This clearly shows how slow and insignificant the process of heat

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[20] In his memoir (Wien Sitzb, vol. 34) Stefan obtained for the value of the diffusivity of the air

$$a^2=\frac{k}{c_v\rho}=\frac{0.0000558}{0.1686\times.001293}=0.256 \text{ [cm.}^2\times\text{sec.}^{-1}].$$

But $a^2=\frac{k}{c_p\rho}$ and not $\frac{k}{c_v\rho}$, where c_p is the specific heat of the air at constant pressure, and c_v at constant volume.

Therefore $a^2=\frac{k}{c_p\rho}=\frac{0.0000558}{0.23788\times0.001293}=0.1812$ [gm. $\times$ cm.$^{-1}\times$ sec.$^{-1}$].

[21] Poyning and Thomson, Heat, p. 233.

[22] Nature, January 4, 1872; also Ferrel's Recent Advances in Meteorology, p. 171.

conduction is when compared with radiation. Consequently we have to deal only with radiation in our problem of the nocturnal cooling of the atmosphere, except when the atmospheric strata very near the earth's surface are considered.

At first thought it appears that, according to Kirchhoff's law, any radiation from a mass of air may be of such a quality as to be immediately absorbed by the adjacent air in passing through it, and therefore can not escape into space, except when radiated by the very outermost stratum of the atmosphere. But the radiation by gaseous matter is very different from radiation by a solid or liquid. The latter radiates its heat from its surface only, but in the case of a gas every particle of it radiates into space directly. The experiments on radiation of ice and the observations of nocturnal frosts show that most rays of even such low temperatures can pass through thick strata of clear atmosphere without material absorption [23].

It is evident that the earth's surface at nighttime undergoes changes of temperature by the three processes:

a. Increase of temperature by conduction from the interior of the earth upward, that is, by the amount of

$$k'\left[\frac{\partial \theta'}{\partial x}\right]_{x=0} dt.$$

b. Increase of temperature by absorption from the lower strata of the atmosphere, or of

$$h\,(\theta_{x=0}-\theta'_{x=0})\,dt.$$

c. Decrease of temperature by radiation toward the sky, amounting to

$$-\sigma'\,(\theta'_{x=0}-\theta_1)\,dt.$$

Whence the change of temperature

$$[d\,\theta']_{x=0}=\left[k'\frac{\partial \theta'}{\partial x}\right]_{x=0} dt+h\,(\theta_{x=0}-\theta'_{x=0})dt-\sigma'\,(\theta'_{x=0}-\theta_1)\,dt$$

or

$$\left[\frac{\partial \theta'}{\partial t}\right]_{x=0}=\left[k'\frac{\partial \theta'}{\partial x}\right]_{x=0}+h\,(\theta_{x=0}-\theta'_{x=0})-\sigma'\,(\theta'_{x=0}-\theta_1). \quad (8)$$

As we are going to deal with the relation between the temperatures of the earth's surface and the atmosphere later on, $h\,(\theta_{x=0}-\theta'_{x=0})$ may be dropped off from the expression (8). Moreover, the emissivity of the air is very small compared to that of the earth's surface and $h\,(\theta_{x=0}-\theta'_{x=0})$ may be insignificant. Then we have

$$\left[\frac{\partial \theta'}{\partial t}\right]_{x=0}=\left[k'\frac{\partial \theta'}{\partial x}\right]_{x=0}-\sigma'\,(\theta'_{x=0}-\theta_1). \quad (9)$$

For the interior temperature of the earth,

$$\frac{\partial \theta'}{\partial t}=a'^2\frac{\partial^2 \theta'}{\partial x^2}. \quad (10)$$

These two equations determine the temperature of the earth's surface. Putting $u_{x=0}=\theta'_{x=0}-\theta_1$ and $u=\theta'-\theta_1$, equations (9) and (10) become

$$\left[\frac{\partial u}{\partial t}\right]_{x=0}=\left[k'\frac{\partial u}{\partial x}\right]_{x=0}-\sigma' u \text{ for } x=0. \quad (11)$$

$$\frac{\partial u}{\partial t}=a'^2\frac{\partial^2 u}{\partial x^2}. \quad (12)$$

In these equations x has been counted positive downward from the earth's surface. By observations, we know that there is a certain depth, say $x=\varepsilon'$, where there is no effect of the daily change of temperature at the surface, and such a layer we call the stratum of invariable temperature. Now let us measure x from this stratum upward. Then the equations (11) and (12) become

$$\left[\frac{\partial u}{\partial t}\right]_{x=\varepsilon'}=\left[k'\frac{\partial u}{\partial x}\right]_{x=\varepsilon'}-\sigma' u_{x=\varepsilon'} \text{ for } x=\varepsilon'. \quad (13)$$

$$\frac{\partial u}{\partial t}=a'^2\frac{\partial^2 u}{\partial x^2}. \quad (14)$$

[23] Helmholtz, Ueber atmosphärische Bewegungen, 1888; also Abbe's "Mechanics of the Earth's Atmosphere," p. 89.

In addition to these, there enters the boundary condition,

$$\frac{\partial u}{\partial t}=0 \text{ for } x=0. \quad (15)$$

Now the expression

$$e^{-a'^2\lambda^2 t}\sin \lambda x \quad (16)$$

is a particular solution of the differential equation (14) and satisfies the condition (15) also.

Substitute (16) for $u_{x=\varepsilon'}$ in (13), and we have

$$-a'^2\lambda^2\sin\lambda\varepsilon'=k'\lambda\cos\lambda\varepsilon'-\sigma'\sin\lambda\varepsilon'$$

$$(\sigma'-a'^2\lambda^2)\sin\lambda\varepsilon'=k'\lambda\cos\lambda\varepsilon'.$$

Let $\omega=\lambda\varepsilon'$ or $\lambda=\frac{\omega}{\varepsilon'}$, then

$$\tan\omega=\frac{k'\,\omega\,\varepsilon'}{\sigma'\varepsilon'-a'^2\,\omega^2}. \quad (17)$$

The transcendental equation (17) has an infinite number of unequal roots; let them be denoted by ω_1, ω_2, ω_3, etc.

Then we have, for the general solution which satisfies our conditions, the following expression:

$$u_{x=\varepsilon'}=A_1 e^{-\left(\frac{\omega_1}{\varepsilon'}\right)^2 a'^2 t}\sin\omega_1+A_2 e^{-\left(\frac{\omega_2}{\varepsilon'}\right)^2 a'^2 t}\sin\omega_2+\ldots\ldots$$

$$\theta'_{x=\varepsilon'}=\theta_1+A_1 e^{-\left(\frac{\omega_1}{\varepsilon'}\right)^2 a'^2 t}\sin\omega_1+A_2 e^{-\left(\frac{\omega_2}{\varepsilon'}\right)^2 a'^2 t}\sin\omega_2$$

$$+A_3 e^{-\left(\frac{\omega_3}{\varepsilon'}\right)a'^2 t}\sin\omega_3+\ldots\ldots \quad (18)$$

If we take the first term of (18) for the first approximation

$$\theta'_{x=\varepsilon'}=\theta_1+A_1 e^{-\left(\frac{\omega_1}{\varepsilon'}\right)^2 a'^2 t}\sin\omega_1.$$

Differentiate this with respect to t, after taking logarithms,

$$\log\,(\theta'_{x=\varepsilon'}-\theta_1)=\log A+\log\sin\omega_1-\left(\frac{\omega_1}{\varepsilon'}\right)a'^2\,t$$

$$\frac{d\,\theta'_{x=\varepsilon}}{(\theta'_{x=\varepsilon'}-\theta_1)}=-\left(\frac{\omega_1}{\varepsilon'}\right)^2 a'^2\,dt$$

whence

$$\left[\frac{\partial \theta'}{\partial t}\right]_{x=\varepsilon'}=-\left(\frac{\omega_1}{\varepsilon'}\right)^2 a'^2\,(\theta'_{x=\varepsilon'}-\theta_1) \quad (19)$$

which is the first approximation to the formula for the nocturnal cooling of the earth's surface.

We may assume that the nocturnal cooling of the atmosphere near the earth's surface is caused principally by the cooling of the latter. Then we have the relation,

$$\frac{\partial \theta}{\partial t}=-b^2\,(\theta-\theta'_{x=\varepsilon'}). \quad (20)$$

Now if we solve (19) and (20) simultaneously

$$\theta=\theta'_{x=\varepsilon'}+pe^{-b^2 t}$$

$$\theta_{x=\varepsilon'}=\theta_1+qe^{-\left(\frac{\omega_1}{\varepsilon'}\right)^2 a'^2 t}$$

whence

$$\theta=\theta_1+pe^{-b^2 t}+qe^{-\left(\frac{\omega_1}{\varepsilon'}\right)^2 a'^2 t}$$

or

$$\theta=\theta_1+pe^{-\frac{\sigma}{\rho c}t}+qe^{-\left(\frac{\omega_1}{\varepsilon'}\right)\frac{k'}{\rho' c'}t} \quad (21)$$

where ω_1 is the first root of

$$\tan\omega=\frac{k'\,\omega\,\varepsilon'}{\sigma'\varepsilon'^2-a'^2\omega^2} \quad (22)$$

p and q may be easily determined.

Putting

$$\begin{cases}\beta=b^2=\dfrac{\sigma}{\rho c}\\ \alpha_1=\left(\dfrac{\omega_1}{\varepsilon'}\right)^2\dfrac{k'}{\rho' c'}\end{cases}$$

(21) becomes

$$\theta=\theta_1+pe^{-\beta t}++qe^{-\alpha_1 t}. \quad (23)$$

If $t=0$, $\theta=\theta_0$

$$\therefore\quad \theta_0=\theta_1+p+q$$

$$\theta_0-\theta_1=p+q. \quad (24)$$

Differentiate (23) with respect to t,

$$\frac{\partial\theta}{\partial t} = -\beta p e^{-\beta t} - a_1 q e^{-a_1 t}.$$

If the initial rate of cooling is represented by r, the last equation becomes

$$\left[\frac{\partial\theta}{\partial t}\right]_{t=0} = r = \beta p + a_1 q. \tag{25}$$

By solving (24) and (25) simultaneously, we obtain

$$p = \frac{a_1(\theta_0 - \theta_1) + r}{a_1 - \beta}$$

$$q = \frac{\beta(\theta_0 - \theta_1) + r}{\beta - a_1}.$$

Hence our equation (23) becomes

$$\theta = \theta_1 + \frac{a_1(\theta_0 - \theta_1) + r}{a_1 - \beta} e^{-\beta t} + \frac{\beta(\theta_0 - \theta_1) + r}{\beta - a_1} e^{-a_1 t} \tag{26}$$

or

$$\theta = \theta_1 + \frac{\left(\frac{\omega_1}{\varepsilon'}\right)^2 \frac{k'}{\rho' c'} (\theta_0 - \theta_1) + r}{\left(\frac{\omega_1}{\varepsilon'}\right)^2 \frac{k'}{\rho' c'} - \frac{\sigma}{\rho c}} e^{-\frac{\sigma}{\rho c} t} + \frac{\frac{\sigma}{\rho c}(\theta_0 - \theta_1) + r}{\frac{\sigma}{\rho c} - \left(\frac{\omega_1}{\varepsilon'}\right)^2 \frac{k'}{\rho' c'}} e^{-\left(\frac{\omega_1}{\varepsilon'}\right)^2 \frac{k'}{\rho' c'} t}$$

and

$$\frac{\partial\theta}{\partial t} = -\left\{ \beta \frac{a_1(\theta_0 - \theta_1) + r}{a_1 - \beta} e^{-\beta t} + a_1 \frac{\beta(\theta_0 - \theta_1)}{\beta - a_1} e^{-a_1 t} \right\}. \tag{27}$$

The equation (27) represents the rate of cooling of the atmosphere at night under our assumed conditions which closely approximate nature in the temperate and tropical zones.
For $t = 0$, we get

$$\left[\frac{\partial\theta}{\partial t}\right]_{t=0} = r.$$

These equations take the same form as Maurer's equations, but my transcendental equation is $\tan \omega = \frac{k' \omega \varepsilon'}{\sigma' \varepsilon'^2 - a'^2 \omega^2}$ while Maurer's is $\tan \omega = \frac{k' \omega}{\sigma' \varepsilon'}$ which was deduced under the erroneous assumption pointed out in my first paper.

If we take more than one root of the transcendental equation, we may be able to express θ in the following series:

$$\begin{aligned}\theta_0 = \theta_1 &+ \frac{a_1(\theta_0 - \theta_1) + r}{a_1 - \beta} e^{-\beta t} + \frac{\beta(\theta_0 - \theta_1) + r}{\beta - a_1} e^{-a_1 t} \\ &+ \frac{a_2(\theta_0 - \theta_1) + r}{a_2 - \beta} e^{-\beta t} + \frac{\beta(\theta_0 - \theta_1) + r}{\beta - a_2} e^{-a_2 t} \\ &+ \text{etc.}\end{aligned} \tag{28}$$

where as before

$$\beta = \frac{\sigma}{\rho c}$$

$$a_1 = \left(\frac{\omega_1}{\varepsilon'}\right)^2 \frac{k'}{\rho' c'}$$

$$a_2 = \left(\frac{\omega_2}{\varepsilon'}\right)^2 \frac{k'}{\rho' c'}$$

$$a_3 = \left(\frac{\omega_3}{\varepsilon'}\right) \frac{k'}{\rho' c'}, \text{ etc.}$$

These equations (26), (27), (28) represent the nocturnal variation of the temperature and the rate of the nocturnal cooling of the atmosphere near the earth's surface. It is apparent from these equations that both the temperature variation and the rate of the cooling depend upon the coefficients, $a'^2 = \frac{k'}{\rho' c'}$, the diffusivity of the earth, σ', its emissivity, σ, the radiating power of the atmosphere, ρ, its density, and c, its specific heat, and also ε', the depth of the stratum of invariable temperature in the earth. These coefficients may vary with the change of temperature, but, as the nocturnal variation of temperature is comparatively small, they may be supposed constant, which I believe is approximately correct.

Nocturnal cooling and temperature variation also depend upon θ_1 and r.

Approximate values of physical constants:

$a'^2 = \frac{k'}{\rho' c'} = 0.50$ gr. cm./min. $= 30.00$ gr. cm./hr., for earth [Wild].
$k' = 0.30$ gm. cm./min. $= 18.00$ gr. cm./hour, for earth [Wild].
$\sigma' = 0.006$ gm. cm./min. $= 0.36$ gr. cm./hour, for earth [Stefan].
$\varepsilon' = 1$ meter. [Wild].
$b^2 = \frac{\sigma}{\rho c} = 0.13$ gr. cm./hour, for air. [Maurer].

There is much to be said about these physical constants. None of these values, given above or elsewhere, can be trusted absolutely. They await more accurate redeterminations by physicists and meteorologists. The most doubtful constant of all is σ, the coefficient of radiation by the air. According to Maurer, a cubic centimeter of air at 0° and 760^{mm} of pressure radiates $.007 \times 10^{-4}$ cals. per minute, but according to Trabert, $.0077 \times 10^{-5}$ cals. Thus the radiation per hour of one gram of air at 0° C. toward a surface of absolute 0° temperature is 9.83 cals. Maurer finds indications that his coefficient is larger in summer and smaller in winter and that the coefficient found for the air saturated with moisture, or mixed with dust, is larger than belongs to a pure, dry air. He further notes that similar computations based on observations made at high stations, St. Bernard and Santis, give a coefficient about 15 per cent smaller. On the other hand, Trabert draws the conclusion from his observations that the radiation of a unit mass of air is simply proportional to the absolute temperature and that the coefficient of atmospheric radiation is independent of the density of air. By reason of all these observations and computations, there arises a doubt whether the values of σ, obtained by Maurer and Trabert, represent the actual radiation coefficient. Some years ago, Prof. C. C. Hutchins, of Bowdoin College, attempted to determine this coefficient by experimental methods. His value is 100 times larger than those of Maurer and Trabert. It is evident that Hutchins's value is too large, and Maurer's and Trabert's values are too small. Maurer's computation depends upon the Newtonian law and considers average radiation during cloudy, as well as clear, nights, while the metallic tube in Hutchins's experiments was overheated and may have given off an extra quantity of dust or of gaseous compounds, all of which tend to increase the radiation. Hutchins's latest measures are given in the American Journal of Science (4), vol. 18, October, 1904, pp. 277-286. C. C. Hutchins and J. C. Pearson, "Air Radiation." This memoir is reprinted in the MONTHLY WEATHER REVIEW for July, 1904.

According to Wild,[24] the diffusivity a'^2 of the earth, like black earth, sand, clay, etc., is of constant value 0.50 grm. cm./min., at the average temperature 11° C, and the conductivity, k', may be accepted as 0.3 approximately.

If we assume that the earth's surface has a maximum emissivity, we may be able to calculate its value from Stefan's result of experiments on the emissivity of a black body[25]. According to Stefan, the difference of the quantities of heat emitted by a black surface of 1 sq. cm. at 100° C and at 0° C is approximately 1 calorie, or

$$A\,[\,(273+100)\,]^4 - (273)^4\,] = 1 \text{ cal.}$$

whence

$$A = .7245\ldots \times 10^{-10} = .725 \times 10^{-10}$$

$$\sigma' = .725 \times 10^{-10} \times [\,(273+1)^4 - 273^4]$$

$$= .006 \text{ cal. per minute.}$$

The depth of the invariable stratum ε' is 1 m., according to Wild, and at this depth the change is only one hundredth of one degree centigrade during the day.

[24] "Ueber die Boden temperaturen in St. Petersburg und Nukuss." 1878-79.

[25] "Ueber die Beziehung zwischen der Wärmestrahlung u. die. Temperatur." Sitzb. Kgl. Akad. Wiss. 1879.

Taking these constants as true, our transcendental equation becomes

$$\tan\omega = \frac{\kappa_1\,\omega\,\varepsilon'}{\sigma'\varepsilon'^2 - a_1^2\omega^2} = \frac{18 \times 100\,\omega}{(0.36 \times 100^2 - 30\,\omega^2)}$$

$$= \frac{60\,\omega}{120 - \omega^2}.$$

Now in order to find the roots of this equation graphically we put

$$y = \tan\omega \qquad (a)$$

and

$$y = \frac{60\,\omega}{120 - \omega^2} \qquad (b)$$

and construct two sets of curves taking y as ordinates and ω as abscissas. Then the values of the abscissas of the intersecting points of curves will be the roots of $\tan\omega = \frac{60\,\omega}{120 - \omega^2}$.

The equation (a) is a well known transcendental equation. The second one presents a new curve, whose characteristic points are

$$y = 0 \text{ for } \omega = 0.$$
$$y = 0 \text{ for } \omega = \infty.$$
$$y = \infty \text{ for } \omega^2 = 120 \text{ or } \omega = 10.95.$$

For maximum or minimum points,

$$\frac{dy}{d\omega} = 60\,\frac{120 + \omega^2}{120 - \omega^2} = 0$$

whence

$$120 + \omega^2 = 0$$

$$\omega = \sqrt{-120}.$$

Hence, we see that there is no maximum or minimum. For $y = \tan\omega$ we compute the following table:

ω	*In radians.*	*In angle.*	*Tan* ω.
$\frac{1}{10}\left(\frac{\pi}{2}\right)$	= .1571	9°	.1584
$\frac{2}{10}\left(\frac{\pi}{2}\right)$	= .3141	18°	.3249
$\frac{3}{10}\left(\frac{\pi}{2}\right)$	= .4712	27°	.5095
$\frac{4}{10}\left(\frac{\pi}{2}\right)$	= .6282	36°	.7265
$\frac{5}{10}\left(\frac{\pi}{2}\right)$	= .7854	45°	1.0000
$\frac{6}{10}\left(\frac{\pi}{2}\right)$	= .9424	54°	1.3764
$\frac{7}{10}\left(\frac{\pi}{2}\right)$	= 1.0995	63°	1.9626
$\frac{8}{10}\left(\frac{\pi}{2}\right)$	= 1.2564	72°	3.0777
$\frac{9}{10}\left(\frac{\pi}{2}\right)$	= 1.4139	81°	6.3138
$\frac{\pi}{2}$	= 1.5708	90°	∞

For $y = \frac{60\omega}{120 - \omega^2}$ we compute the following values:

ω	y	ω	y
1	0.50	7	6.00
2	1.03	8	8.55
3	1.62	9	13.80
4	2.30	10	30.00
5	3.16	10.95	∞
6	4.30	12	−30.00

ω	y	ω	y
14	−11.05	28	−2.50
16	− 7.60	30	−2.30
18	− 5.30	40	−1.60
20	− 4.30	50	−1.26
22	− 3.62	60	−1.03
24	− 3.15	100	−0.60
26	− 2.80	200	−0.30

Plotting these values, will give two sets of curves like those in the accompanying diagram, fig. 1.

$$\frac{177}{128}\pi = 4.344 \text{ for } \omega_1$$

$$\frac{313}{128}\pi = 7.685 \text{ `` } \omega_2$$

$$\frac{7}{2}\pi = 10.995 \text{ `` } \omega_3$$

etc., etc.

$$B = .1300$$

$$a_1 = \left(\frac{\omega_1}{\varepsilon'}\right)^2 \frac{k_1}{\rho'\,c'} = \left(\frac{4.344}{100}\right)^2 \times 30 = 0.0568.$$

Hence,

$$\theta = \theta_1 - \frac{.0568\,(\theta_0 - \theta_1) + r}{.0732}\,e^{-.1300\,t} + \frac{.1300\,(\theta_0 - \theta_1) + r}{.0732}\,e^{-.0568\,t}$$

$$\omega_2 = 7.685.$$

$$a_2 = \left(\frac{7.685}{100}\right)^2 \times 30 = .1776.$$

$$\left\{\begin{array}{l} \dfrac{a_2(\theta_0 - \theta_1) + r}{a_2 - \beta}\,e^{-\beta t} = \dfrac{.1776(\theta_0 - \theta_1) + r}{.0476}\,e^{-.1300\,t} \\[2ex] \dfrac{\beta(\theta_0 - \theta_1) + r}{\beta - a_2}\,e^{-a_2 t} = -\dfrac{.1300(\theta_0 - \theta_1) + r}{.0476}\,e^{-.1776\,t} \end{array}\right.$$

$$\omega_3 = \left(\frac{10.995}{100}\right)^2 \times 30 = 0.3628$$

$$\left\{\begin{array}{l} \dfrac{a_3(\theta_0 - \theta_1) + r}{a_3 - \beta}\,e^{-\beta t} = \dfrac{.3628(\theta_0 - \theta_1) + r}{.2328}\,e^{-.1300\,t} \\[2ex] \dfrac{\beta(\theta_0 - \theta_1) + r}{\beta - a_3}\,e^{-a_3 t} = -\dfrac{.13(\theta_0 - \theta_1) + r}{.2328}\,e^{-.3628\,t} \end{array}\right.$$

Summing up these terms we obtain,

$$\theta = \theta_1 + \left\{ -\frac{.0568(\theta_0 - \theta_1) + r}{.0732} + \frac{.1776(\theta_0 - \theta_1) + r}{.0476} + \frac{.3628(\theta_0 - \theta_1) + r}{0.2328} \right\} \times e^{-.13t} + \Big(.13\,(\theta_0 - \theta_1) + r\Big) \times$$
$$\times \left\{ \frac{1}{.0732}\,e^{-.0568\,t} - \frac{1}{.0476}\,e^{-.1776\,t} - \frac{1}{.2328}\,e^{-.3628\,t} \right\}$$

The meaning of θ_1 is already explained elsewhere, but as regards its nature and magnitude, θ_1 gives rise to a multitude of questions. Let us imagine for a moment that an elementary volume of air is exposed in the atmosphere to nocturnal radiation. Then this volume will receive heat from two different sources, namely, from interplanetary space and from the atmosphere, if the radiation from the earth's surface is cut off. The sidereal heat, which name we owe to Poisson, is the total heat which reaches the earth from all celestial bodies excepting the sun. This heat is called star heat by Haughton; temperature of space, or weltraumstemperatur, by Frölich. Fourier was the first to show that it is necessary to take account of this sidereal heat in order to explain the phenomena of nocturnal radiation, and to indicate in a general way that the heat ought to be very little inferior to the temperatures of the poles of the earth, and about 50° or 60° below zero C. Poisson believed that this heat is higher than that pointed

out by Fourier and concluded that it differs very little from zero temperature and that it has the same intensity in all directions, when it reaches the earth. On the other hand, Pouillet and Frölich attempted to separate the constant effect of the sidereal heat from the variable effect of the atmosphere; and Pouillet found the temperature of sidereal heat to be —142° C., and Frölich —131° C. from his St. Petersburg observations. With respect to the heat emitted by the atmosphere itself in the course of the night, it is the effect of the individual radiations of the concentric upper strata of the atmosphere. It depends, consequently, upon the distribution of temperature in upper atmospheric regions.

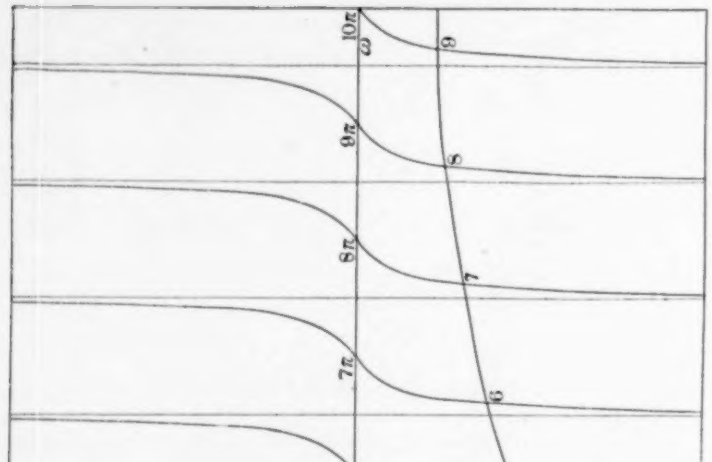

Fig. 1.—Graphic solution of the transcendental equation.

Whatever be the relation of the intensities of the two causes just mentioned, it is evident that we may conceive of a single cause producing an effect equal to that which results from the simultaneous action, or, in other words, we may suppress the sidereal heat and the heat of the upper atmosphere, and conceive an *imaginary athermanous surface*, of maximum emissive power, the temperature of which is such that it imparts to the elementary volume of air as much as it receives from the upper atmosphere and from space. This unknown temperature was called the zenithal temperature by Pouillet, the sky temperature by Ferrel, and himmelstemperatur by Frölich. I prefer to call it the temperature of the imaginary athermanous surface, and it is denoted by the notation θ_1 throughout the present analysis. According to Haughton, the mean value of θ_1 is —108.16° F. Frölich, who has recently made important researches on the subject, with greatly improved instruments, at St. Petersburg, has obtained about the same value as that of Haughton. It is evident that since the sidereal heat is constant, but the heat emitted by the atmosphere is variable, the temperature of the imaginary athermanous surface must experience some variation. Pouillet's experiments with his actinometer during very beautiful, clear nights show that the temperature θ_1 is lowered during the night, from the setting to the rising of the sun. This variation of θ_1, however, can not be very great, as the temperature of the atmosphere by the upper regions is constant through all the seasons and all the night. According to Teisserenc de Bort's observations in his 581 balloon ascensions, the temperature gradient of the atmosphere becomes smaller the higher we ascend, and at last the temperature becomes constant throughout all the seasons at the height of 8000 meters. Professor Wild observed that the daily oscillation of the temperature becomes smaller as we go upward, and vanishes at the height of 30 meters. Hence it is clear that that part of the atmosphere which may be the cause of the variation of θ_1 during the night is only a thin stratum. Moreover, the emissive power of the atmosphere is a very small quantity, and so the variation of θ_1 in clear weather, if it exist at all, must be very small. It is, however, highly important to determine the exact value of θ_1 experimentally or otherwise, and to investigate its variation and also the ratio or any other relation of the sidereal heat to the heat emitted by the upper atmosphere.

If we know the physical constants for ice, we can apply the formulæ developed above to the study of the nocturnal cooling of the atmosphere over ice surfaces, by replacing the coefficients for the earth by those for ice. Or, if the earth's surface is covered by a very thin layer of snow, we can deal with the problem by replacing only the emissivity for the earth's surface by that for snow.

In conclusion, a few words must be said. In the first paper, I have given a historical summary of observational work on the nocturnal cooling of the atmosphere by Wilson, Six, Wells, Pouillet, Melloni, and others; and then pointed out the errors and weak points in the theories of the problem advanced by Lambert, Weilenmann, Haughton, Maurer, and Nakamura. In the second paper, I have, by quoting from Maurer's, Helmholtz's, and Wells's work, shown how extremely small is the effect of heat conduction upon the nocturnal cooling of the atmosphere, and have also shown that Maurer's estimation of the effect is too large and Helmholtz's is too small. Neglecting the effect of heat conduction, I have now attempted to solve the problem by taking advantage of Weilenmann's and Maurer's differential equations, but have adopted a more legitimate assumption as regards the thermal relation between the atmosphere and the earth's surface, since Maurer's assumption is erroneous. I have thus obtained a new transcendental equation, whose roots furnish new values for the solution of the differential equations. Then I have discussed the physical constants which come in the analysis and reduced my general formulæ into numerical expressions by introducing the approximate values of the physical constants. Finally, the meaning of θ_1, the imaginary athermanous surface, was explained and the importance of further research on its magnitude and variation was pointed out.

As already explained elsewhere, the problem of the nocturnal cooling of the atmosphere is extremely complex and difficult for modern mathematical analysis. It appears to me that the phenomena of the atmospheric radiation may not yield to

analytical methods so long as the necessary physical bases are lacking. Neither of the coefficients adopted above is absolutely reliable. Besides, in order to complete the solution of the problem and verify the results of mathematical analysis, we must have at hand the results of simultaneous nocturnal observations of the temperature of the atmosphere at different heights (say, from $x = 0$ to $x = 30$ meters) and of the temperature of the earth's surface and the soil at different depths. We need accurate knowledge of the position of the strata of invariable temperature in the earth and in the atmosphere. As pointed out elsewhere, we must also know more completely the magnitude and variation of the imaginary athermanous surface and of its functional relation to the sidereal heat and the temperature of the upper atmosphere. This paper does not pretend to contribute anything toward the final solution of the problem; but in the present status of our knowledge of the subject, even an approximate analysis may yet prove of importance. This statement is justified by Lord Rayleigh's introductory words in his memoir on the Vibrations of an Atmosphere:[26]

> In order to introduce greater precision into our ideas respecting the behavior of the earth's atmosphere, it seems advisable to solve any of the problems that present themselves, even though the search for simplicity may lead us to stray rather far from the actual question.

In preparing the account of this research, I am indebted to many writers, from whose books and memoirs I freely quoted in order to support my views on the subject. I would especially mention Dr. J. Maurer's important memoirs, often mentioned previously. I take the advantage of this opportunity to express my gratitude for valuable criticisms and suggestions, to Prof. R. S. Woodward, now President of the Carnegie Institution, whose masterly command of mathematical analysis in physical inquiry and whose clear and lucid exposition have been the source of inspiration that led me to pursue the study of mathematical physics with great enthusiasm; and to the Editor of the Monthly Weather Review, under whose kind direction I have been engaged in meteorological research and who proposed the present problem[27] for investigation. I have also to thank Prof. A. Graham Bell, of Washington, D. C., and Dr. L. A. Bauer, the Director of the Department of Terrestrial Magnetism of the Carnegie Institution, for their cordial assistance in many ways.

THE INFLUENCE OF SMALL LAKES ON LOCAL TEMPERATURE CONDITIONS.

By James L. Bartlett, Observer Weather Bureau. Dated April 25, 1905.

The city of Madison, Wis., is situated between Lakes Mendota and Monona on a strip of land trending northeast and southwest and varying in width from one-half to three-fourths of a mile. Since April, 1883, meteorological observations have been taken at Washburn Observatory, which is located at one end of this strip on a slight ridge overlooking Lake Mendota, the larger of the two lakes; the observatory is 100 feet above and 600 feet distant from this lake. Besides the two lakes mentioned there are several smaller ones in the vicinity, so that within a radius of five miles from the observatory the surface is about one-third water. It would therefore appear to be a very favorable location for observing any appreciable effects that the lakes may have upon the local air temperature.

To obtain an accurate knowledge of these effects it was found necessary to compare the Washburn Observatory temperatures with those of neighboring points which have no lakes in their vicinity. For this purpose the records at the four cooperative observation stations nearest to Madison were selected. These are Harvey, Portage, Beloit, and Dodgeville, located, respectively, to the east, north, south, and west of Madison and within a radius of 45 miles from the last-named city.

For periods of the same lengths and dates in each case for Madison and for the point under consideration the following temperature data for each calendar month were computed: mean, mean maximum, mean minimum, and mean daily range. Corrections for the differences in the mean annual temperatures of the various places were then applied. Thus, the mean annual temperature at Beloit was found to be 1.3° higher than that at Madison for the period under consideration; this amount was therefore deducted from all of the Beloit data, except the mean daily range. The resulting values were presumed to show the temperature conditions which would exist at Madison were there no lakes in its vicinity. The departures of the Madison temperature data from the corrected data of the other points were then computed and are plotted below. The departures are shown in degrees Fahrenheit and are positive above the zero line, negative below. The curves, reading downward in each case, show the departures, respectively, from the Harvey, Portage, Beloit, and Dodgeville data.

The departure curves of fig. 1 show certain general points of agreement. The mean maximum and mean daily range curves have a negative departure, and the mean minimum a positive departure during nearly all the year in each case. The mean monthly curve has a general negative departure during the first five months and a general positive departure the remainder of the year. The mean minimum reaches its extreme positive departure in August in each case. It is believed that the irregularities of certain of the curves, particularly of those of the mean maximum, are due to local peculiarities of the climate of the various points. Thus, Beloit and Harvey are nearer to, and therefore their temperatures are more under the influence of, Lake Michigan than is that of Madison. Dodgeville is more remote from the great lake and less affected by it. Portage is in the valley of the Wisconsin River, which doubtless has some influence upon local temperature conditions. To eliminate these irregularities as far as possible an average of the departures was plotted for each element of the temperature data, and this may now be considered.

The monthly mean departure curve (fig. 1, No. 19) shows quite clearly the slight influence which the lakes have in retarding the annual increase of temperature in the spring and its decrease in the fall. This seems to be manifested in the spring by a lowering of the maximum or day temperatures, and in the fall chiefly by a raising of the minimum or night temperatures.

The influence of the lakes in preventing the occurrence of killing frosts late in the spring and early in the fall is quite marked, and is indicated by the positive departure of the minimum curve from April to October. The average date of the last spring killing frost at Madison is April 21; the average date for Harvey, which has nearly the same latitude as Madison and is nearer Lake Michigan, during the past thirteen years has been over two weeks later. In the fall killing frosts occur in general two weeks earlier at Harvey than at Madison. It would thus appear that the growing season is considerably lengthened at Madison by the presence of the lakes.

During January and February the lakes are almost invariably thickly coated with ice, and presumably the local exposure then becomes purely continental. That the frozen lakes do exert some control upon the temperature of the overlying air is shown by the fact that the range of temperature at Madison during these months still averages over two degrees less than at points away from the lakes. Also the monthly mean is slightly below the assumed purely continental type at this time, but it is possible that this should not be the case. It seems more reasonable to believe that the whole mean

[26] Phil. Mag., Feb., 1890. Abbe's Mechanics of the Atmosphere, p. 289.
[27] The third and fourth papers on the subject will be published in a subsequent number of the Monthly Weather Review.

monthly departure curve should be raised sufficiently to eliminate the negative departures during January and February, a step which would be equivalent to assuming that the mean annual temperature at Madison is slightly increased by the presence of the lakes. This, however, can not be proved from the data at hand.

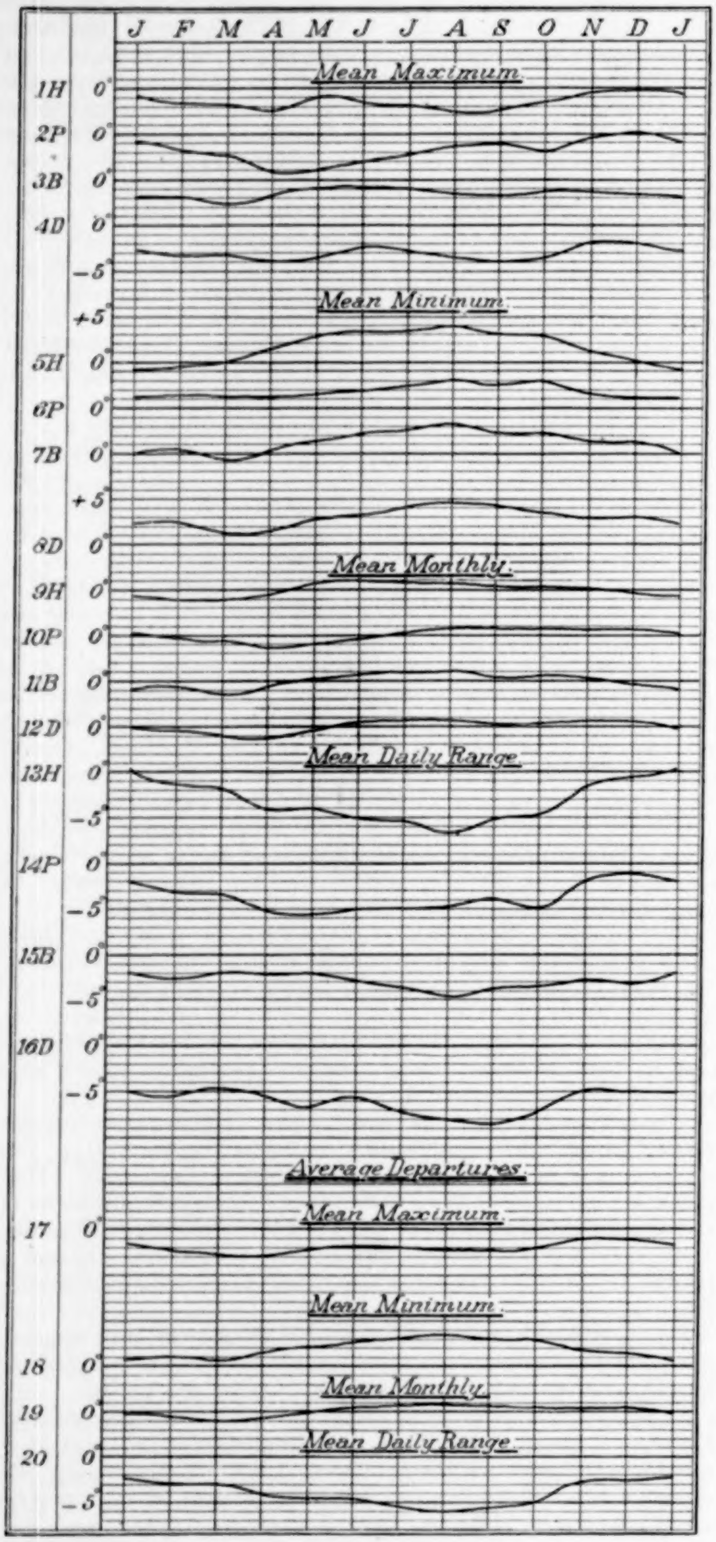

Fig. 1.—Departure curves.

In August the minimum curve reaches its extreme positive departure and the daily range of temperature averages six degrees less than that of neighboring purely continental exposures. Doubtless this is due to the presence of much water vapor in the air over the now well warmed lakes, this vapor absorbing much of the heat radiated from the sun during the day and from the earth at night. The high minimum during August indicates why the vicinities of small lakes during this month are less desirable pleasure resorts than at other seasons of the year.

The most marked tendency of the Madison temperature conditions to return to the purely continental type is shown in the curves from October to November, although the local lakes do not close until about December 21 as a rule. The freezing over of the lakes is usually preceded by several days of cold weather during which the temperature may fall nearly to zero. This cold spell frequently culminates on the day of closing and the succeeding few days are somewhat warmer. No decided change to the strictly continental type appears to occur near the date of closing, although a study of the Madison records for each year shows that the average decrease in temperature from the month preceding this date to the month following is about three degrees more than the normal.

While the exposure at Madison especially favors the influence of the lakes on the observed temperatures, yet it is believed that wherever small lakes are found, the temperature conditions in their vicinity will show departures from the purely continental type of their section much resembling those given above, though not so marked.

THE GREAT INDIAN EARTHQUAKE OF APRIL 4, 1905, AS RECORDED AT THE WEATHER BUREAU.

By Charles F. Marvin, Professor of Meteorology.

The great earthquake that almost entirely destroyed the mountain towns of Dharmsala, Kangra, and Palampier, in northwestern India, causing great loss of life and property over a wide extent of adjacent territory, was very fully recorded at Washington, D. C., on the Bosch-Omori seismograph at the Weather Bureau.

There is very little about the record to suggest that the disturbance was one of unusual character. In fact, we have records of other earthquakes apparently of decidedly greater violence, but whose foci appear to have been remote from populated regions. On this account or for some other reasons the disturbances were not marked by such great disaster and destruction as to draw widespread attention to their occurrence. Consequently our records in these cases have not been correlated with any published accounts of earthquakes.

In the case of the Indian earthquake, the vibratory motion as recorded at Washington persisted for an unusually long time (two hours and thirty minutes); but, on the other hand, that part of the record embracing the maximum displacement of the recording pen was relatively of short duration. It is reproduced in fig. 1.

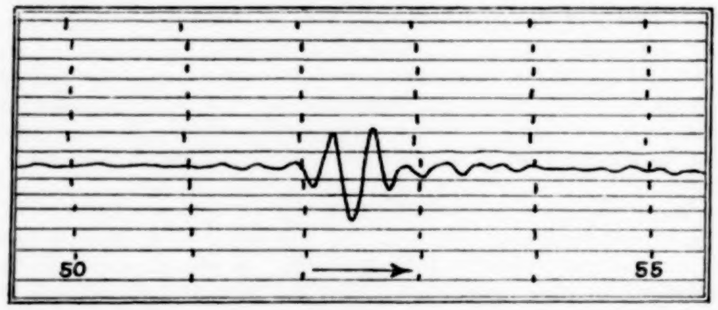

Fig. 1.—Maximum waves of Indian earthquake as recorded at Washington. Time correction +13 seconds.

The following table gives in detail the noticeable characteristics of the whole record.

Earthquake of April 4, 1905, seventy-fifth meridian time.

	h.	m.	s.
First preliminary tremors began	8	14	49 p. m.
Second preliminary tremors began	8	36	13 p. m.
Principal portion began	8	51	15 p. m.
Principal portion ended	8	54	13 p. m.
Maximum waves at	8	52	40 p. m.
End of earthquake	10	45	7 p. m.

Duration of first preliminary tremors	21 min.	24 sec.
Duration of second preliminary tremors	15 "	2 "
Duration of principal portion	2 "	58 "
Total duration of earthquake	2 hr. 30 "	18 "

Average complete period of small waves of principal portion	20 sec.
Average complete period of large waves of principal portion	15 "
Average complete period of small waves at end of principal portion	19 "
Period of pendulum	28 sec.
Maximum double amplitude of actual displacement of earth at seismograph	1.23 mm.
Magnification of record	10 times.

The north-south component of horizontal motion only was recorded.

The approximate location of the focus of this earthquake appears to have been somewhere near Dharmsala which seems to have suffered the greatest devastation. The geographic coordinates of Dharmsala are longitude 76° 23′ east; latitude 32° 16′ north. This point and Washington (longitude 77° 3′ west; latitude 38° 54′ north) may be located on a projection of the globe at *D* and *W*, respectively, as seen in fig. 2, where *P* is the north pole, and Dharmsala is considered to be located in the plane of the paper.

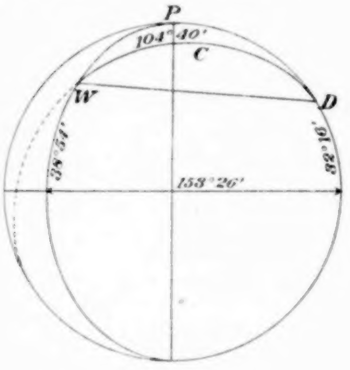

FIG. 2.

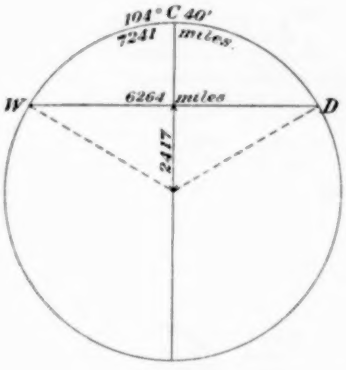

FIG. 3.

A brief consideration of some of the geophysical questions suggested by an examination of the data available indicates how imperfectly the structure and elastic properties of the earth are understood.

In fig. 2, *W C D* represents the arc of the great circle through *W* and *D*; that is, the shortest distance between the two points measured on the surface of the earth. *W D* likewise is the direct path from *W* to *D* through the interior of the earth. From trigonometry we find *W C D* is an arc of 104° 40′; that is, a linear distance of 7241 statute miles. An earthquake traveling to Washington along this great circle would arrive from a direction 23° 40′ east of north.

Fig. 3 shows the relative positions of Washington and Dharmsala on the great circle of the earth, *W C D*, passing through them. The distance on the chord, *W* to *D*, is 6264 miles, and at the nearest point the line passes within 2417 miles of the center of the earth; that is, at a maximum depth below the surface of 1539 miles. In these computations the earth is regarded as a perfect sphere having a radius of 3956 miles, and the focus of the earthquake is assumed to lie within a few miles of the surface.

Data are not at present at hand giving the exact time of occurrence in India of any specified phases of the earthquake, but a report from Mussooree, located about 2° of longitude east of Dharmsala, states that the time of the severe shocks was 6:10 a. m., April 4, presumably local time. The corresponding local time at Dharmsala would be 6:02 a. m. The time of the first tremors at Washington, reduced to the Dharmsala meridian, would be about 6 hours 21 minutes a. m., making the time consumed in transmission about 19 minutes. If the waves were propagated along the surface of the earth and over the arc of a great circle, the speed of propagation from these figures must have been at nearly the rate of 6.4 miles (10.3 kilometers) per second; if propagated along the chord, the speed must have been nearly 5.5 miles (8.9 kilometers) per second.

The velocity of propagation of elastic waves in ordinary solid media is proportional to $\sqrt{\frac{E}{d}}$, where E is Young's modulus of elasticity, and d the density. It appears from the tables of the velocity of sound waves in different media that, owing to the high elasticity and small density of certain kinds of glass, elastic waves are propagated therein at a greater velocity than in any other known material, viz: 19,690 feet per second = 3.7 miles per second.

From these considerations it appears that the calculated speed of propagation of the Dharmsala earthquake wave along the surface path is 73 per cent greater than the highest observed wave velocity in glass. Even if the waves followed the linear path through the interior of the earth the velocity of transmission would still be 49 per cent greater than the velocity in glass.

These statements relate to the propagation of the first earthquake tremors or small waves which travel at the highest velocities, and therefore reach distant points long before the great waves. The maximum waves traveled to Washington at a far slower rate, viz: 2.3 miles per second along the arc, and 2.0 miles per second along the chord.

The high speed waves are generally believed to be longitudinal waves, that is they consist of alternate compressions and expansions along the line of propagation analogous to the sound waves. If this be the case and the waves in the present earthquake traveled along the chord, then they should have seemed to emerge at Washington at a relatively high angle, i. e., 37° 40′ from the zenith. No measurement of this angle was actually made at Washington, but there is a mass of observational evidence to show that the vertical component of earthquake motion is so small that it has rarely been successfully measured, except near the origin, and then it is generally a small proportion of the horizontal motion. In the earthquake of April 4 the maximum north-south horizontal component of displacement at Washington was 1.23 mm. If the wave traveled on the chord, the corresponding component of vertical motion would have to be 1.74 mm. If a large component of this character existed it would be easy to measure it.

It seems very probable that earthquakes that are registered at great distances from their origin are propagated through very deep lying masses of the earth which appear to be highly elastic. The motions that are registered after coming out at the surface along the line of propagation are really secondary phenomena, representing effects set up in the relatively loose, nonhomogeneous surface layers by the deep-seated vibrations that are being propagated below.

Just what path is actually taken by the waves in cases of this sort is still an unsettled question among seismologists, and no generally satisfactory explanation of the high speed of propagation as related to the known elastic qualities of the earth has yet been given.

RECENT PAPERS BEARING ON METEOROLOGY.

R. A. EDWARDS, Acting Librarian.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau. Unsigned articles are indicated by a ——

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Boys, H. A. A parallel continued. Pp. 51-52.

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Fletcher, Francis. The legend of Sahara dust falls. Pp. 53-54.

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Hogg, J. L. Viscosity of air. Pp. 611-612.

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Ward, R. DeC. The climate of Tibet. [Note on address of Frank Younghusband.] P. 229.

Ward, R. DeC. Autumn rainfall and the yield of wheat in England. [Note on work of W. N. Shaw.] P. 231.

H., G. D. English fogs and commerce. [Note on report of U. S. Consul Mahin.] Pp. 231-232.

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A[llan], G. E. Manometer device for air thermometers.. [Abstract of article of H. Edwards.] P. 226.

B[orns], H. Daily temperature variation in the higher atmosphere. [Abstract of article of Teisserenc de Bort.] P. 231.

B[orns], H. Oscillation of solar activity and climate. [Abstract of article of C. Easton.] Pp. 231-232.

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B[orns], H. High barometer and temperature inversion, end of January. [Abstract of article of W. H. Dines.] P. 232.

S[tewart], J. J. Radio-active emanations in the atmosphere. [Abstract of article of A. Gockel.] P. 244.

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—— Eine merkwürdige Störung in der Erscheinung der Bishopschen Ringes. [Abstract of article of J. Maurer.] Pp. 375-376.
—— Untersuchungen über den Föhn in Innsbruck. [Abstract of article of H. von Ficker.] Pp. 376-377.
—— Die Höhe des Vogelfluges in der Luft. P. 380.

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Julius, W. H. Erklärung der spektroheliographishen Ergebnisse durch anomale Dispersion. Pp. 221-222.

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—— Staubfall auf den Kanarischen Inseln. P. 170.
—— Meteorologische Beobachtungen in Boroma (Südafrika). P. 170-172.
Hann, J. Täglicher Gang des Barometers zu Quixeramobim. Pp. 172-173.
Conrad, V. Ueber die Elektrizitäts-Zerstruung auf dem Sonnblick. Pp. 173-174.
Hann, J. Die jährliche und die tägliche Periode der Gewitter in Südindien. P. 175.

Hansky, A. Aktinometrische Beobachtungen auf dem Montblanc. Pp. 176-177.
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Kesslitz, W. Wetterkartenindex als Hilfsmittel für die Wetterprognose. Pp. 183-185.
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RECENT ADDITIONS TO THE WEATHER BUREAU LIBRARY.

R. A. EDWARDS, Acting Librarian.

The following titles have been selected from among the books recently received, as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies. Most of them can be loaned for a limited time to officials and employees who make application for them.

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RHODODENDRON LEAVES AS THERMOMETERS.

By JOHN F. JOHNSON.

[From Country Life in America, November, 1904, vol. 7, No. 1, p. 72.]

Rhododendron leaves constitute a fairly reliable natural thermometer. The photographs were all taken from the same plant at different temperatures. The first picture, taken with the thermometer at 45° F., shows the normal or flat condition during mild weather. Waiting until the thermometer registered 17° F., I photographed the same branch, and found the leaves in the position illustrated in fig. 2[1], a drooping of the leafstalks and an inward curling of the blades having taken place.

After noting this change in conditions, I was interested to find out what effect a sudden rise in temperature would have upon the leaves, so I took this branch away and placed it in a temperature of 45° F. Immediately, with a springing motion, the leaves started to expand, the leafstalks to straighten themselves, and in eight minutes both leaves and leafstalks had reverted to their normal condition. Thus, it will be observed that the transition in the conditions of the leaves from fig. 2 to fig. 1 occupied a space of time not much exceeding that which mercury would take to cover the same number of degrees, under similar conditions. Having noted the effect of a rise in temperature, I set the same branch outside again in 17° F. This time the leaves took twenty minutes—nearly three times as long—before they reached the condition of fig. 2.

Fig. 3 illustrates the effect of zero weather on another branch from the same bush. Here the leaves I found to be much more tightly rolled up, the edges in most cases curling inward to touch the midrib on the under side. The difference between fig. 2 and fig. 3, or 17° F., will be observed to be fairly proportionate to that between fig. 1 and fig. 2.

Nature has a purpose for all these metamorphoses. Less transpiration and consequently less loss of heat is the result of this curling. This power in living plants of conforming to external circumstances is called irritability. Somewhat analogous to the above is the closing up and sleeping of clover leaves at night. Tulip flowers also exhibit this power of closing and expanding under different temperatures. When placed in a heated room, during sunshine, or mild weather outdoors, the petals expand, but will contract and close together when subjected to reduced temperature.

FAKE RAINMAKING—A LETTER FROM THE CHIEF OF BUREAU.

U. S. DEPARTMENT OF AGRICULTURE, WEATHER BUREAU,
Washington, D. C., April 5, 1905.

EDITOR THE TOLEDO BLADE,
Toledo, Ohio.

DEAR SIR: In reference to a dispatch from Riverside, Cal., which appeared in your issue of March 29, and which stated that heavy rains had occurred in southern California during the past winter as the result of a single rainmaking station established on the slope of Mount Wilson, permit me to say that the liberation of chemicals on Mount Wilson had nothing to do with the rainfall in southern California. Your dispatch stated that the heaviest rain fell in the region of the rainmaker, and that the rainfall had not been large in any of the other regions of the subarid West. This statement is erroneous, as during the same period general and excessive rains occurred throughout Arizona and New Mexico. The cause of heavy rains was not local, but was associated with general abnormal atmospheric conditions over the United States that were in turn associated with abnormal conditions that obtained over a large part of the Northern Hemisphere.

It is known that when barometric pressures for a month are low in the Southwest[2] the period is one of frequent and heavy rains in that region, and this barometric condition pre-

[1] The photographs are omitted as not essential to the main idea of the paper.
[2] That is, the southwest, the north, and the east portions of the United States.—ED.

vailed over New Mexico, Arizona, and southern California during the three-month period under consideration. The association between low barometric pressure and excessive rains in the Southwest[2] and high barometric pressure and unusual cold in the North[2] and East[2] has also been established. It has been observed, in fact, that during winters of excessive cold in the northern and eastern districts of the United States the seasons have been unusually wet from western Texas to southern California.

During the past winter the associated conditions referred to have prevailed, and they have resulted in frequent and generally excessive rains not alone in southern California but in all of the immense territory that extends thence eastward to Texas.

It is, therefore, apparent that the rainfall which was supposed to have been caused by the liberation of a few chemicals of infinitesimal power was simply the result of general atmospheric conditions that prevailed over a large area. It is hoped that the people of southern California will not be misled in this matter and give undue importance to experiments that doubtless have no value. The processes which operate to produce rain over large areas are of such magnitude that the effects upon them of the puny efforts of man are inappreciable.

Very truly yours,

(Signed) WILLIS L. MOORE,
Chief U. S. Weather Bureau.

WIND VELOCITIES FOR DIFFERENT ALTITUDES AND EXPOSURES.

By ALEXANDER J. MITCHELL, Section Director, Jacksonville, Fla.

On August 1, 1902, the Weather Bureau office in Jacksonville was removed from the Astor Building to the Dyal-Upchurch Building. As a result, there was a change in the elevation of the anemometer cups amounting to 45 feet.

The mean hourly wind movement for the several months shows that the increase in elevation of nearly half a hundred feet results in an increase of wind velocity averaging about two miles per hour based on data for the two years ending July, 1904, as compared with the previous two years, 1900–1901 and 1902, before the removal of the office from the Astor Building. See Tables 1 and 2. Of course, these data have no conclusive value, being for only a limited time.

It is believed, however, that data for five years will show as great, or greater, hourly value as that now indicated. Certainly more verifying velocities have occurred and less pronounced pressure gradients give higher wind velocities than was the case at the old location.

In connection with wind velocity varying with the elevation of the anemometer cups as a result of better circulation and more freedom from obstructions, the average hourly velocities for the lustrum 1875-1879, with an elevation of 23 feet, the office being at the National Hall Building, and the lustrum 1897-1901, elevation 84 feet, when the office was at the Astor Building, are shown in Tables 3 and 4. In this case, with a difference in elevation of the anemometer cups amounting to 61 feet, the average difference per hour was only one mile.

Assuming that data for the lustrums used are reasonably correct and that during the period considered average weather conditions prevailed, it would appear that an increase in elevation of anemometer cups of 50 to 60 feet results in an increase of approximately one mile per hour in the lower circulation at this station.

TABLE 1.—*Astor Building. Average hourly velocity, years 1901-2. Elevation of anemometer cups, 84 feet above the ground.*

Years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1900	....	....	....	....	....	....	....	6	7	7	6	7
1901	8	7	9	10	9	7	7	7	9	8	7	8
1902	7	9	9	7	7	8	7	....	....	....	....	....

TABLE 2.—*Dyal-Upchurch Building. Average hourly velocity, years 1902-3. Elevation of anemometer cups, 129 feet above the ground.*

Years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1902	....	....	....	....	....	....	....	9	9	10	9	9
1903	10	12	10	11	10	9	8	8	11	9	10	9
1904	11	10	10	11	9	10	9	....	....	....	....	....

TABLE 3.—*Average hourly velocity for the lustrum 1875 to 1879. Elevation of anemometer cups, 23 feet. National Hall Building.*

Years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1875	6	7	8	8	8	6	7	6	7	6	7	6
1876	6	7	8	6	6	8	7	6	7	7	6	6
1877	5	7	8	8	8	7	7	6	6	8	7	7
1878	7	8	7	7	6	6	6	5	8	6	6	6
1879	6	7	6	8	7	6	6	6	7	8	6	6
Average	6	7	7	7	7	7	7	6	7	7	6	6

TABLE 4.—*Average hourly velocity for the lustrum 1897 to 1901. Elevation of anemometer cups, 84 feet. Astor Building.*

Years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1897	7	8	9	8	7	7	7	6	8	7	7	6
1898	7	7	8	8	7	7	7	8	8	8	8	8
1899	8	9	8	9	7	7	7	7	7	9	6	8
1900	7	7	8	8	7	7	7	6	7	7	6	7
1901	8	8	9	10	7	7	7	7	9	8	7	8
Average	7	8	8	9	7	7	7	7	8	8	7	7

TORNADOES OF MARCH 17, 1905, IN WESTERN OKLAHOMA.

By C. M. STRONG, Observer, Oklahoma, Okla.

The morning weather map of March 17, 1905, showed a storm of considerable energy, central over Utah, which was causing cloudy weather, showers, southerly winds, and higher temperature over the western Plateau region and the central western valleys.

This storm moved slowly eastward and was central over Colorado by the morning of the 18th.

During the afternoon of the 17th tornadoes and hailstorms developed over western Oklahoma, causing destructive effects over Roger Mills, Kingfisher, and Garfield counties. The storms were noted over Roger Mills County about 4 p. m., and over Kingfisher and Garfield counties about 5 to 6 p. m., ninetieth meridian time.

Sixteen persons were injured and two dwellings destroyed at Poarch, Roger Mills County, and three persons and one dwelling at Garber, Garfield County.

Following are the reports received concerning the several tornadoes:

Poarch, U. N. Waldrup, Postmaster.—Funnel-shaped cloud formed 4 p. m., central time, moved northeast with slight whirling motion from right to left, accompanied by heavy rain, hail, and lightning; length of path, five miles, width, one-half mile; sixteen persons injured, two dwellings destroyed.

[2] That is, the southwest, the north, and the east portions of the United States.—ED.

Bison, Postmaster.—Funnel-shaped cloud at 5 p. m., central time, moved northeast with a right to left motion, accompanied by heavy rain and lightning; path observed about eight miles long, width, 50 feet; two outbuildings destroyed; two distinct tornadoes formed, one to southwest, the other to northeast of Bison, both traveling northeast.

Garber, B. A. Garber, Postmaster.—Funnel-shaped cloud at 6 p. m., central time, moved northeast with left to right motion, trees falling to west on north side, and east on south side, in center of path following direction of storm; accompanied by heavy rains, hail, and lightning, and a loud roar; cloud black; length of path two miles, width, two hundred yards; Mrs. B. Shawver and three children injured, and the Shawver house and outbuildings destroyed, total loss, $1500.

SOME TEMPERATURES TAKEN ON LAKES HURON AND SUPERIOR IN JULY AND AUGUST OF 1904.

By F. L. Odenbach, S. J., Director, Cleveland Observatory. Dated April 15, 1905.

From July 19 to 25, 1904, I passed over the Lakes from Cleveland to Duluth. To while away the time I occasionally took some temperatures both of the atmosphere and the water. Finding that these observations proved very interesting to the hydrographer at Duluth, more were taken on the return trip from August 2 to 7. Though not numerous, some of them are interesting and may, as has often been the case, serve to confirm some well conceived theory, or to discourage one which has been too daringly advanced.

The weather during the trip from Cleveland to Duluth was fair, with the one exception of a thunderstorm on Lake St. Clair and Saginaw Bay, which will account for the low temperature of the air at that point. The wind during both passages was light, except on August 2, at night, when we experienced a pretty stiff breeze from the east. On July 24, from 10 to 11 a. m., we observed a mirage above the hills south of Marquette. The temperatures here given were taken on the shady side of the ship. Water was drawn up the side in a tin can, the thermometer read three or four times within five minutes, the instrument then dried and the temperature of the atmosphere taken with the same thermometer.

The temperature of the water in the tin can was observed to remain steady for about ten minutes, or so long as the tin remained wet on the outside; when dry it began to rise slowly.

The very low temperature of 39.2° off Stannard Rock is very remarkable. I was so surprised that I dipped water two or three times and called on the captain to take a reading in order to be certain that I was not deceived. The night was bitter cold and the sky as clear as I have ever seen it.

FROM CLEVELAND TO DULUTH.

Date.	Water.	Atmosphere.	Location.
	°	°	
July 22, 10 a. m.	63.5	61.5	Off Saginaw Bay.
7 p. m.	62.6	61.7	Off Middle Island.
July 23, 7 a. m.	60.8	57.2	Mud Lake.
8 p. m.	55.4	50.0	Off Vermillion Point.
July 24, 7 a. m.	39.2	44.6	Off Stannard Light.
July 25, 7 a. m.	51.8	57.2	Outer Island.
noon	62.4	64.4	
3 p. m.	63.8	68.0	
5 p. m.	55.2	67.6	Bark Bay.

FROM DULUTH TO CLEVELAND.

Date.	Water.	Atmosphere.	Location.
	°	°	
August 2, 11 a. m.	64.6	70.1	Two miles east of Duluth.
2 p. m.	62.2	64.4	
3 p. m.	63.6	68.0	
5 p. m.	55.0	67.6	
8 p. m.	54.5	62.0	Sand Island.
9 p. m.	50.0	56.6	
11 p. m.	51.8	....	
August 3, 7 a. m.	48.2	50.0	Off Fourteen-mile Point.
10 a. m.	51.8	59.0	Five miles west of Portage Canal.
10.30 a. m.	58.8	65.3	Mouth of canal.
noon	68.5	76.1	Pilgrim Point buoy.
2 p. m.	55.4	70.7	East end of canal.
5 p. m.	57.2	62.2	Huron Island.
8 p. m.	57.2	62.6	Off Stannard Rock.
midnight	48.2	....	Grand Island.
August 4, 6 a. m.	44.6	55.8	Fifteen miles off Grand Marais.
1 p. m.	56.3	67.2	Whitefish Point.

The course sailed was by way of Detour Channel. From St. Marys River NW. ½ N. to Whitefish Point; then W. ½ N. for Huron Island, thence W. ⅝ S. for Portage River; from west end of river W. ½ S. to Devils Island; then SW. ¼ W. to Duluth. With the fair weather we were making seventeen knots per hour.

The return was made over the same course.

A COLD WEATHER DUST WHIRL.

By F. W. Proctor, Fairhaven, Mass., dated March 13, 1905.

On the morning of March 13, 1905, just before 11 o'clock, the writer observed an interesting dust whirl that had generated over frozen ground. It seems to be worth reporting, in view of the tendency among meteorologists to exclude convection as a factor in the large whirls of the winter half of the year.

The sky was clear, the wind nearly calm as shown by the rising smoke columns from chimneys, though there was a gentle movement of the air from the southwest, the barometer high, and the shade temperature fifteen minutes later was 31.5° F., as shown by a sling thermometer.

The whirl formed over or near a macadamized highway. It was first noticed by reason of the rustling of the branches of some roadside trees, and since it did not die out or move away within about a minute, it was thereafter timed by the watch. By moving along the highway a little, it was possible to approach the center of the whirl, and the horizontal wind there was estimated at twelve miles an hour. Owing to the scarcity of loose litter on the fields and gardens nearby, it was not possible to observe the vertical velocity of the air currents, and the entire diameter of the whirl. But at the expiration of five minutes, the inflowing wind could plainly be perceived when the center was shown by small pieces of whirling débris to be about 100 feet away.

Fortunately just then a triangular piece of newspaper about 12 by 18 inches was picked up by the whirl, and could be watched continuously during the next five minutes. The paper rose slowly, without regular gyration, to a height estimated at 500 feet or more, drifted slowly toward the northeast, and finally disappeared without falling, so far as could be observed.

Thus, the whirl endured at least eleven minutes, and probably considerably longer.

The preceding night was cold enough to freeze the ground, and the morning insolation must have been mainly used up in softening the surface. Under these conditions, with the air temperature at 31.5° F., there could not have been much heating of the lower air layers except over the highway, which was drier than the adjacent lands, and would become heated more easily.

Apparently the whirl formed over the highway, but it soon moved off; and it would seem that its further activity must have been due in large part, to cooling aloft.

NOTE ON THE WINDS OF THE REGION ADJACENT TO THE GULF OF CALIFORNIA.

By Prof. George H. Stone, Mining Engineer.

I spent the winter of 1900-1901 in the Chiricahua Mountains in southeastern Arizona. In December a series of storms began, which lasted till the next May. At first the storms came at intervals of three or four weeks, but gradually they came oftener till March and April, when it snowed and sleeted almost continuously for nearly a month. All these storms were preceded and accompanied by southerly winds.

The winter of 1904-5 I have spent near Arizpe, Sonora, Mexico. There had been almost no rain in this region for three years until last July, when the summer rains were very violent. In November there were one or two very light rains. Early in December we had a more severe rain, which lasted three days. Then the weather was pleasant until early in January, when it rained very violently for several days. Then the

storms became more frequent, at first once a week, then every three to five days, until in late February and early March it rained almost every day, often several times a day in the form of showers. The weather of 1900-1901 is being repeated after the long intermediate drought. In all these storms the rain-bearing winds have come from the south, or a little east or west of south, hence from the ocean. Several thousand miles of wind have passed northward.

It does not appear probable that such long-continued winds are wholly connected with passing areas of low barometer. They more nearly resemble persistent monsoons, perhaps the anti-trades. It is generally supposed that the summer movement of Pacific air northward and eastward over Mexico and the adjacent portion of the United States is due to a partial vacuum over the heated land. The winter movement must be due to a *plenum* over the sea, if we use the correlative term.

Several questions arise—

1. What relation do these movements of moist sea air eastward and northward over the lands adjacent to the Gulf of California bear to the anti-trades, the Pacific region of calms, and the area of high barometer of the northern Pacific Ocean?

2. How far north and east do these winds carry their moisture?

3. What connection did the extremely wet, alternating with dry, seasons have with the recent great variations of solar radiation observed by Professor Langley by aid of the bolometer?

4. Did the volcanic eruptions have any effect on these seasons?

Postscript.—Dated March 22, 1905, at Arizpe, on the Sonora River, in Sonora County, Mexico, latitude N. 30° 20′, longitude W. 110°, Greenwich.

It rained every day till it ended in a tremendous downpour on March 8-9. Then it was pleasant for three days; then we had one and one-half days of heavy showers, clearing up by the 15th. The high cirrus streamers on the 15th showed that the upper circulation was from a little north of west. The Sonora River has been so high that it could not be crossed by horses and wagons, and there are no bridges. The storm of March 13-14 was the heaviest of the season and since then no rain, except two little showers. Twice the high cirrus has set in from the southwest, but, in less than 24 hours, veered to the northwest, and during three days there was no sign of cirrus or other cloud.

A HEAVY DEPOSIT OF HOARFROST AND ITS EFFECT IN RETARDING NOCTURNAL COOLING.

By DEWEY ALSDORF SEELEY, B. S., Observer, Weather Bureau, Peoria, Ill.

On the morning of February 26, 1905, there was an unusually heavy deposit of frost and the idea was suggested of attempting to measure the actual amount of precipitation thereof, in the form of water. Accordingly a smooth, horizontal, wooden surface, about one foot above ground, was selected as a place of measurement and the task undertaken. The large galvanized portion of the rain gage was inverted upon this surface, thus marking out a circular area covered with frost, the size of the top of the rain gage. This frost was then carefully collected, by means of a large knife, and placed in the brass portion of the rain gage, the latter having previously been partially filled with water at about 60°. Several measurements of the depth of water in the gage, before and after the frost was placed therein, were very carefully made. The increase in depth resulting from the addition of the melted frost deposit was determined to be very nearly 0.018 inch.

The question was then suggested as to the heating effect of the condensation of so large an amount of vapor into frost. This was roughly determined by means of the formula

$$V = \frac{WH}{10\ W'S},$$

V being the volume of air heated 10° F., W the weight of the frost deposit per square foot, or 0.09284 pounds; H the number of heat units given out by the condensation of vapor into frost, or 1092; W' the weight of a cubic foot of saturated air at 30° F., and under a pressure 30.00 inches, or 0.081 pound; and S the specific heat of air at a constant pressure, or 0.238. From this formula V equals 525 cubic feet. In other words sufficient heat was evolved from the condensation of 0.018 inches of water, from vapor to frost, to raise the temperature of the air for about 525 feet above the surface by an average of 10° F., provided this heat was all consumed in heating the air. It can not be assumed that the heat thus evolved from the condensation of vapor into frost on a clear night is directly effective in warming the air, as it is probably very largely radiated through the atmosphere unimpeded. However, this heat does supply a large amount of the energy which is radiated from the surface of the ground and retards the cooling of the latter, thereby having a tendency to retard the rapid cooling of the atmosphere in contact therewith.

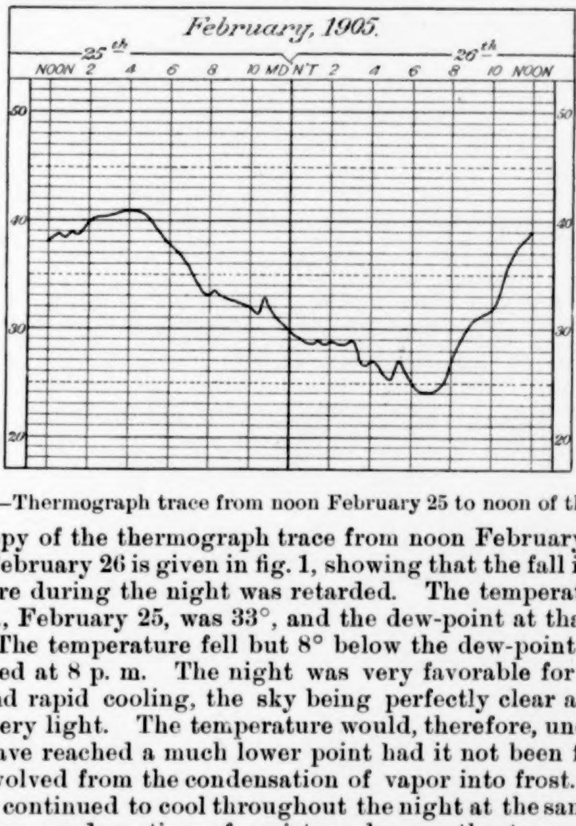

FIG. 1.—Thermograph trace from noon February 25 to noon of the 26th.

A copy of the thermograph trace from noon February 25 to noon February 26 is given in fig. 1, showing that the fall in temperature during the night was retarded. The temperature at 8 p. m., February 25, was 33°, and the dew-point at that time 32°. The temperature fell but 8° below the dew-point as determined at 8 p. m. The night was very favorable for radiation and rapid cooling, the sky being perfectly clear and the wind very light. The temperature would, therefore, undoubtedly have reached a much lower point had it not been for the heat evolved from the condensation of vapor into frost. Had the air continued to cool throughout the night at the same rate as before condensation of moisture began, the temperature would have reached 5°, whereas the minimum on the morning of the 26th was but 24°.

It is reasonably certain that a deposit of dew or frost will prevent the temperature from falling many degrees below the dew-point, as determined in the afternoon or evening preceding. Truck gardeners, cranberry growers, and others who are so greatly affected by the occurrence of frosts, and who can, in a measure, allay the destructive effects by means of flooding, "smudging," etc., might often be able to forecast with reasonable certainty whether a frost is liable to occur at a time when conditions seem favorable for it, by determining the temperature of the dew-point late in the afternoon. If the latter is near the freezing point a frost may be expected, providing other conditions favor it, but if the dew-point is found to be 8° or 10° above 32° the heat of condensation can be depended upon to prevent freezing.

TORNADO OF APRIL 14 NEAR PENSACOLA, FLA.

By WM. F. REED, jr., Observer, Weather Bureau.

A tornado was reported near Beulah Settlement, twelve miles northwest of Pensacola, Fla., at 10 p. m., April 14, 1905, eastern time.

The barometer readings over the eastern and southern portions of the country on the morning of the 14th were unusually low. Three areas of low pressure were charted, which were encircled by isobars of 29.7 inches, one around Denver, Colo.; one around Palestine, Tex., and the other inclosing Wytheville, Va., and Charlotte, N. C., with indications of southeasterly movement of high pressure from the northwest. The morning barometer at Pensacola was 29.81 inches, with the relative humidity 93 per cent. A local thunderstorm occurred from 6:05 to 7:10 p. m., and came from the southwest. The highest velocity for the day was twenty miles, from the southwest, at 11:48 p. m. The sky remained cloudy during the night, with strato-cumulus clouds prevailing.

The following account of the tornado was obtained from Mr. Arthur Spare, Cantonement, Fla.:

The storm of the 14th of April was undoubtedly a small tornado, or, as we called it, a "twister." It seemed to be the culmination of two storms, starting close together. It rained very hard for a few minutes, when it began to hail from the northwest. The hail came twice from that direction in intervals of about five minutes, the hailstones both times being round or slightly oblong, smooth, hard, and as large as hazel nuts. A second hailstorm came from the southeast, with heavy rain and wind. The hailstones in this instance were flat, about three-fourths of an inch in diameter and three-eighths of an inch thick, with rough, ragged edges. It was one continuous storm of wind, rain, and hail for the time it lasted, and did not slack up raining when the wind changed. The hardest part of the storm lasted for 30 minutes, the rain continuing an hour longer. There was plenty of lightning, but not much thunder. The amount of rainfall can not be determined. A funnel-shaped cloud was described to me by two neighbors who saw it. There was a roaring sound accompanying the storm, which came from the southwest and moved generally toward the northeast, showing zig zag path in some places. The presence of a whirl is plainly shown by the distribution of débris. At one place the path is 50 yards wide, the trees on one side lying with their tops toward the southwest, and fifteen steps from there is a tree twisted off with its top the other way. I traced the path for about one-half of a mile. It mixed up things badly at my old house, where the path is fifteen yards wide, and will take much of my time to straighten up matters again.

NOTES AND EXTRACTS.

UNUSUAL WEATHER AT DODGE, KANS.

The following is a letter from Mr. E. D. Emigh, assistant observer, temporarily in charge of the Weather Bureau station at Baltimore, Md.:

TO THE EDITOR:

Permit me to add the following note to your interesting comment on my article concerning the unusual weather conditions at Dodge, Kans., during the last week in February and the first week in March, published in the MONTHLY WEATHER REVIEW, p. 51, for February, 1905.

A short explanation of certain features of the phenomenon may not be amiss. Upon striking the ground or cold objects against which it was driven by wind, the mist formed into a solid sheet of ice, as assumed in your remarks; but when it came into contact with woolen clothing the liquid form was retained, however long the clothing had been exposed to the cold air. I presume, therefore, that it is correct to assume that the temperature of the wool must have been sufficiently high to overcome the subcooled condition of the mist.

With reference to the last paragraph of your comment, it was, of course, necessary to melt the ice collected in the receiver of the rain gage before the amount of precipitation could be measured.

SNOW AND FROST CRYSTALS.

Referring to the preceding letter from Mr. E. D. Emigh, we reprint the following extract from the annual report of the Chief Signal Officer for 1891—being a part of the report of Prof. C. F. Marvin, on "Maximum pressure of aqueous vapor at low pressure," pp. 351-386:

NOTE UPON THE ABNORMAL FREEZING OF WATER AND CORRESPONDING VAPOR PRESSURE.

During the progress of the vapor-pressure work considerable difficulty was experienced in freezing the water capsules used in the experiments, and the particular results obtained indicate the possibility of water retaining its liquid condition under very unusual circumstances.

Mention was made on page 360 of the method of breaking the water capsule by freezing. For this purpose the tube *a*, fig. 9,[1] was wholly surrounded by a freezing mixture of salt and ice. In many instances, even after one or two hours' exposure in this manner to a temperature continuously from 3° to 5° below zero, F., the water in the capsule remaining unfrozen. It is true the transfer of heat from the water through the vacuum must undoubtedly have been very slow, taking place quite wholly by radiation, yet the temperature was certainly very low, and the phenomenon of not freezing a real one, as the same result was obtained with a precisely similar capsule directly immersed and moved freely about within the liquid freezing mixture. In this case there could be no doubt as to the temperature. In both of these cases, although it was possible to considerably agitate and jar the capsule, yet the water so very nearly filled it as to be but very little disturbed; nevertheless in the case of the free capsule the small bubble of space within could be made to move about from end to end, etc., yet without the slightest effect to induce solidification. It was therefore found necessary to lower the temperature still further to effect freezing, which was generally successfully accomplished at temperatures from —10° to —15° F. I am disposed to believe, however, that the real temperature of the water in such cases may doubtless have been little lower than —5°, but that it could be appreciably higher than 0° seems scarcely credible under the circumstances.

In more than one instance solidification took place within the capsule, but peculiarly enough it was not broken thereby, and, in consequence, I have even been to the annoyance of entirely refilling the apparatus in order to introduce a new capsule of thinner glass and presumably less strong. Subsequent experience, however, led me to believe that in all these cases the failure to break the capsule was really due to the fact that a part only of the water was frozen, and had sufficient time been given, the capsule must surely have burst. It was at first imagined, since the solidification was practically instantaneous, that the whole mass froze at once. This, however, does not appear to be the case, as is indicated by the following considerations: Water in freezing must give off about 140 units of heat. If now, without freezing, the temperature be lowered to, say, —5° F., that is, 37° below the normal freezing point, about 37 units of heat have been withdrawn in lowering the temperature more than is really necessary. When, therefore, solidification once starts the dissipation of 37 units of the latent heat of freezing can take place with great suddenness and operates to warm up the whole mass of water to its normal freezing point, and further solidification can take place only on the slow dissipation of the latent heat.

Phenomena of this character were repeatedly observed with different capsules, and subsequently a few other experiments in the same direction were made. Thus, a capsule of somewhat larger dimensions was attached to a piece of spirit-thermometer tubing having a comparatively fine bore. This was filled with well-boiled, distilled water and sealed up after the manner of a thermometer.

The elimination of air from the water or the space above was by no means so perfect in this thermometer as in the capsules used in the vapor-pressure tubes. Marks were made on the tubes at the points opposite the top of the water column when the bulb was in ice, and also at the temperature of maximum density. Thus, the water was made to roughly indicate its own temperature, but more particularly showed the changes in volume with temperature. When the bulb was immersed and moved about within the freezing mixture, the column would soon fall to the point of maximum density, and would gradually ascend again and pass considerably beyond the line marking the volume at the freezing point, showing thereby that the *expansion observed to take place in water, from the point of maximum density to the normal freezing point, is continuous when under any circumstances the water may be cooled below this normal freezing point without solidification.* As soon, however, as the water reaches the point at which it will start to freeze, there is a very sudden solidification of a part of the water, and the increase in volume is very great, forcing the unfrozen water far up into the chamber at the top of the stem.

The structure of the ice in these cases, as, in fact, in all others of sudden freezing, is coarsely crystalline, presenting many arrangements of long, interlacing needles, and giving a somewhat milky color to the whole. An instant's exposure of the frozen bulb to the air quickly loosens the ice from the walls of the bulb, and as it melts slowly can be seen to rise to the top side of the bulb as the latter is revolved or turned about into different positions. The ice seems to be a comparatively compact mass throughout, not shell-like, as might be imagined.

When the small quantities of water used in the vapor-pressure bulbs were subjected to low temperatures, here also freezing never took place at the normal temperature. As the temperature of the bath in which

[1] Not reproduced.

the bulb of the pressure apparatus was immersed was gradually lowered during the observations, it was customary to frequently lift up the bulb and examine if the water was frozen. This was never found to be the case until the temperature was many degrees below the normal freezing point, and no amount of agitation and slopping about of the water had any visible effect in hastening the freezing. It was not practicable to actually witness the freezing; after passing some low temperature the water was found to be frozen. On several occasions the mercurial columns were continuously watched during the lowering of temperature. Presently a sudden increase was observed to take place in the vapor pressure, followed by nearly as sudden a return to the previous condition. The mercurial columns in these cases never reached closely their positions corresponding to the pressure at the normal freezing point. This action takes place no doubt at the instant of freezing and indicates a rise in the temperature. The large surface of exposure of the bulb prevents any great difference of temperature between the vapor within and the bath, and the small quantity of water is very quickly entirely frozen.

On page 368 it is shown how the water may be made to frost itself over the inner surface of the large bulb. On one occasion this was tried by placing the large bulb in the bath at a temperature of about 25° F. After some time the water had entirely distilled into the large bulb, and this being as much as 7° below the freezing point it was expected to find an even coat of frost inside. On examination, however, the vapor had not condensed as frost, and water in the liquid state only was found. The temperature was then lowered, as usual, to nearly 5° before the water, as shown by frequent examinations, and notwithstanding much agitation, was found frozen.

The water in this same bulb, on other occasions, was always frozen at a temperature of 10° as was also the water in the other pieces of apparatus. As near as could be told the temperature of freezing was about 11° to 14° F. We have in this then not only the abnormal existence of water in the liquid state at very unusual temperatures, but a somewhat corresponding behavior of the vapor which does not necessarily solidify on condensation at a temperature lower than the normal freezing point.

This experiment of distillation was repeated on another occasion with the temperature of condensation at about 5° F. In this case the water in the small bulb was almost instantly frozen by its own evaporation and presistently remained so despite moderate applications of heat, such as the hand, warm water, etc. After all the ice had distilled into the large bulb the latter was found to be beautifully coated inside with thin ice crystals.

In order to examine some points respecting the freezing of water under these circumstances, a bulb not encumbered with the manometric tubes and mercurial columns was exhausted and a capsule of water broken within. In this case the water capsule froze and burst after about two hours' exposure in an ice and salt mixture at a temperature not at any time higher than —3° F. The water in this bulb behaved in all respects similar to that in the regular vapor pressure tubes and even when violently shaken could not be frozen until cooled to a temperature of about 12° F. If, however, the water, once frozen, was almost entirely melted, leaving only a small fragment of ice, and then again cooled slightly below the normal freezing point, the whole mass soon became solid. The presence of the small fragment of ice at starting seems necessary to induce solidification at the normal freezing temperature.

When air was admitted to this bulb and the water shaken about for a few minutes, it could be frozen ot 25° F.

ABNORMAL VAPOR PRESSURES.

In all the observations of the vapor pressure, when the temperature of the water was below the normal freezing point and the water still in the liquid state, the pressure was always observed to be greater than when the water at the same temperature was in the form of ice. The following table shows the differences found in the pressures under these circumstances:

Number of observations.	Temperature.	Pressure.		Difference.	
		From ice.	From water.	Ice—water.	Ice—Broch.
	° *F.*				
....	32.00	?	4.568	?	?
3........................	24.83	3.280	3.419	—0.139	+0.007
4........................	19.87	2.591	2.771	—0.180	+0.001
4........................	14.84	2.042	2.237	—0.195	+0.005
1........................	10.06	1.608	1.786	—0.178	—0.022

The same methods have been followed in combining the results by the different tubes, as have been already described in connection with Table III.

Although, in all cases, the water would remain liquid at temperatures far below the normal freezing point, yet, after being once frozen, no melting could be detected until a temperature of 32° was reached. At this point melting always began, and the vapor pressures thus observed can not, therefore, be considered strictly as observed over ice, as it was impossible to prevent incipient melting, giving rise to at least a thin film of water over the ice. The vapor pressures measured over ice at temperatures a fraction of a degree below 32°, and given in the second value in Table III, agree so closely with those over water *exactly at* 32° as to lead to the conclusion that the vapor pressure over dry ice at the melting point is exactly the same as that over water at the normal freezing point.

The striking agreement with Broch's tables of vapor pressures from water at temperatures at which it should be frozen, but still remains liquid, is remarkable and seems very significant.

The last value in the table above is the result of only one observation taken with tube No. 8, which may account, in part at least, for the larger difference in the last column.

The peculiar behavior of water as thus discussed, has in some particulars been observed by others, though the general impression appears to be that a little agitation or disturbance is sufficient to induce freezing whenever the temperature is below the normal freezing point. This is not at all the case with the experiments above described, as the temperature at which solidification took place seemed quite definite and depended wholly upon temperature.

I have not been able to find any note of the abnormal freezing of water under quite the circumstances of my own experiments.

Boussingault (Comptes Rend., Tome LXXIII, p. 77) perfectly filled a very strong steel cylinder with water at its maximum density which was afterwards not frozen upon long exposure at a temperature of —24 C. Here the effect of enormous pressure comes into play.

Dufour (Ann. Chim. et Phys., T. XLVIII, p. 370) discusses the nonfreezing of globules of water in suspension within another liquid of the same density.

Water in very fine capillary tubes has also been observed by Sorby (Phil. Mag., 4th series, Vol. XVIII, p. 105) to retain the liquid state at very low temperatures. Fine mist particles have also been observed to be in the liquid state at temperatures much below the freezing point.

The almost perfect elimination of air and dust particles from the water seems to have very much to do with these peculiar phenomena of solidification.

It is evident that careful search will reveal many forms of crystals growing in cold weather in unlooked for places. In fact in cold countries and in the coldest portions of refrigerating establishments one ought to be able to reproduce at will many hitherto unknown forms of ice crystals. It occurs to us that the nuclei about which crystallization begins or the chemical and physical peculiarities of the solids on which the crystals form, or the quantity and kind of gases dissolved in the pure water may have much to do with their shapes and internal characteristics. With regard to hollow crystals, tubes, or columns of ice, and the hollow bubbles within lamellar crystals and the formation of ice columns in gravelly soil or sheets of ice columns protuding from crevices in the bark of a tree, we would refer to the American Meteorological Journal of April, 1893, Vol. IX, pp. 523–525, where the present writer has given the following statement of the interaction of water and ice as the crystals and columns grow by accretion.

ICE COLUMNS IN GRAVELLY SOIL.

By PROF. CLEVELAND ABBE.

A very pretty subject for observational elucidation, during the spring and fall, consists in studying the true method of formation of the little slender columns of ice that are found at the surface of gravelly soil in moist places after a clear, cool night. The best account hitherto given of this phenomenon is that by Dr. John Leconte in the Proc. Amer. Assoc. Adv. Sci., 1850, Vol. III, pp. 20–34.

My own attention was first called to the subject at Cambridge, Mass., in the spring of 1863, and since then this formation has been observed by me almost every year. It is undoubtedly not only very common in our latitudes and soils, but is also quite an important item in agricultural soil physics.

After a clear, cold night (whether windy or not seems to be immaterial) the surface layer of a moist gravel bed is usually found to be raised up an inch or two by a mass of vertical columns or needles of ice. The lower ends of these do not penetrate the soil below, but rest upon what had the previous evening been the next lower layer of gravel. If the wind be very strong the columns are best developed in the sheltered spots. As soon as the sun strikes the raised layer of gravel and warms the tops of the grains they sink a little and then the solar rays perforate slanting holes into the mass of ice crystals. Only once have I seen the corresponding phenomenon of a thin sheet of parallel ice columns exuding from a vertical crevice in the bark of a tree, many beautiful examples of which are given by Professor Leconte and Sir John Herschel.

Although dissatisfied with the explanation of this phenomenon, as given by Leconte and others, I was, however, unable to frame a more plausible hypothesis until lately, when considering the studies made by

Mr. Milton Whitney on so-called capillary water, it has seemed to me that the following explanation is plausible:

During clear, spring nights the ground a few inches below the surface retains the warmth of the preceding sunshiny day; by reason of this any moisture that may be there present is preserved as liquid water and works its way upward to the atmosphere either as vapor between the gravel grains, or as a thin film of water inclosing each grain and traveling from one to the next up to the very surface itself by capillary action. The films which would inclose the grains of the uppermost layer of gravel are apt to be quickly evaporated, but the films inclosing the grains immediately below that layer are protected from the wind and from diffusion into the dry air above. No sooner have the upper surfaces of the uppermost grains cooled by radiation below the temperature of their lower sides than there begins a process of conduction of heat upward through the body of each grain of gravel. Very soon moisture condenses as a liquid film on the cooling lower side of each grain, and soon afterwards on the upper side of the grain of gravel immediately below it, and so on gradually, as night advances, for a considerable distance downward. When now the uppermost grain has cooled below the freezing point then the next thing that happens is that on its lower surface its thin film of water freezes, and this implies that the water shall freeze last at those points where the upper grain comes in contact with the next lower grains because those points receive a little heat by conduction from below. Thus, at these points the frozen films protrude downward, and the projecting knobs may be considered as minute circles of ice formed in the watery films inclosing the lower grains while the rest of each such film still remains liquid.

Now, liquid water has a great surface tension, while ice has none, and the watery film inclosing any lower grain will almost instantaneously press in under and lift up the little speck of ice that has formed at the point of contact. The loss of heat by radiation from the upper grain continues steadily, and a steady process of conduction of heat goes on from the water of the lower film through the ice crystal at the point of contact up to the upper grain. Hence, there is a correspondingly steady formation of ice at the points of contact, and a continued renewal of the lifting process takes place until, in the morning, we find the upper grains, and even large pebbles, raised up several inches on the tops of tall columns of ice.

Will not some one devise a miniature repetition of this process in the physical laboratory? Let a small vessel be supported by three rounded metallic knobs resting on surfaces which are covered with thin films of water. The vessel should not be so heavy as to force out the films of water, and the surfaces of contact should not be so large that the circular areas have too large radii. The constricting power of a circular hole in a thin film increases inversely as the radius of the hole. A freezing mixture within the vessel should by conduction send down enough cold to produce ice at the points of support, and yet not enough to rapidly freeze any large portion of the film of water. The success of the experiment and of the natural formation of tall columns of ice must depend upon the radii of the frozen circular films at the points of contact and on the rate at which the heat that is absorbed from the lower film, is conducted through the ice and lost by radiation. The delicate adjustment of conditions that will bring this about makes this formation a very interesting physical problem.

When the outer air is frosty, while the sap is pressing up the body of the tree, a thin film of moisture may possibly be supplied from within as fast as the outer film at the surface of a crack may be frozen and lifted, and may thus form the exudations from the trees described by Doctor Leconte and also observed by myself and others.

This explanation of the growth of hollow columns of ice in gravelly soil, applies with slight changes to the hollow stems and plates of snow crystals. The whole subject of the growth of crystalline forms needs elucidation.

The very interesting investigations of Mr. Bentley on snow and frost crystals remind us of the following article copied from the Report of the British Association for 1858, part 2, pp. 40–41:

ON A FRESH FORM OF CRYSTALLIZATION WHICH TAKES PLACE IN THE PARTICLES OF FALLEN SNOW UNDER INTENSE COLD. BY J. WOLLEY, M. A.

In passing a winter in Lapland, it is impossible, whether in observing the tracks of animals, or merely considering day by day the condition of the roads for sledging, or of the snow for the use of snow-skates, not to be struck by the very variable character of the snow, partly caused by winds and fresh falls, partly by the condition of the rime or hoar frost upon the surface, but mainly, as it is soon found, by an alteration in the character of the mass of fallen snow.

In Lapland, as elsewhere, the snow as it falls is of several kinds. But whatever its character, it at first lies more or less lightly on the ground and if the weather is still and not very cold, it may so remain for days; but if the cold increases, the snow rapidly sinks; it becomes at first like sand, is crisp to the tread, bears the smaller animals, and soon becomes suitable for the skidor or snow-skates. When the cold has continued, probably many degrees below zero of Fahrenheit, for two or three weeks, not necessarily consecutive (the phenomena are more especially to be observed in the cold months of January and February), the snow beneath the surface is found to be made up of large pieces of a quarter or a third of an inch in diameter, glittering in the sunshine, clear, heavy, highly moveable upon one another, and seen upon even a hasty examination to be of a beautiful crystalline structure. On a closer inspection, they are found to be somewhat irregular in shape, with the outline of more or less complete hexagons with sides of unequal lengths; they are formed around nuclei by no means placed centrally, often quite where one side of the hexagon should be; and they grow in layers of bars one outside the other, often larger in section, as well as longer, as they recede from the nucleus; these bars (learned gentlemen will excuse me for not describing a crystal more properly) are free from one another, except at the angles; those of each layer lie in one plane, often not the same as the layer which preceded them lies in. At the angles are usually small crystalline projections, rising apparently perpendicular to the general surface of the crystal. These crystals are broken with a slight force; and many of those where the snow has been crushed have lost their nuclear portion, but retain the true hexagonal form.

Snow, in the condition of which I hope to have given at least some faint notion, is called *hieta lumi*, or "sand-snow", in the Finnish language. It yields more water, and hence, even when it is covered by more recent snow, the Laps take the trouble of digging down to it to fill their kettles with. These primitive people also use it in its dry state for washing or cleansing their clothes. After first exposing to the external cold for some hours the dresses they wish to purify, for reasons which I need not further explain, they beat them with sticks upon and under a heap of sand-snow.

When the winter covering of the ground is in this sandy condition (perhaps the moveable state of such shell-sand as that of John o'Groat's house may best represent it in one respect, and the appearance of a bag of clean crystals of salt give some idea of it in another), it is a great advantage to all the animals of the country in supporting their weight, and is a special comfort to the reindeer, from the facility with which they can remove it with their forefeet so as to get at their food beneath. Though intensely cold to a naked hand, it is much better than fresh snow for lying upon, as it does not yield too much to the weight of the body, and does not get into the nicks of the clothes, or melt in the fur. I may mention, that with only a thick pair of stockings on, one can walk for some little distance from a bivouac without risk of getting either wet or cold in the feet; and before a fire in the woods this snow never becomes sloppy, but seems to disappear only by evaporation, which greatly adds to the facilities of passing the long winter nights in a Lapland forest. The same thing is in a great measure true in the spring; the snow is very rarely to be found in that miserable state which marks the breaking up of a snow in England.

Concerning the formation of these crystals, I made experiments by burying in the snow at certain intervals of time, chip boxes, some empty and some containing fresh snow; I was prevented from fully carrying out and registering my observations, but I found that the changes went on in the boxes equally with the external snow, and in the boxes that contained nothing but air, but, nevertheless, were not so tightly closed as to prevent the transmission of air containing water in solution, crystals attaching themselves to the sides and top, but never to the floor, of the box, which crystals greatly resemble those in the snow; they were, however, often much longer, even to upwards of half an inch in length. In the course of my observations, I found that this sand-snow formed principally in open places, on lakes, bare soils, etc., growing less on spongy grounds, scarcely at all upon logs of wood or outbuildings.

TIDAL PHENOMENA.

Associated with the tides are many erroneous notions which appear from time to time in a variety of forms. Several of these constitute the essentials of an article by Mr. S. R. Elson, entitled "Tidal phenomena", which appeared in The Journal, Calcutta, India, for April 9, 1905. It is only because of the persistence of these and similar errors that notice is here taken of the article.

One of these is that the time required for the force of gravitation to traverse space may be considerable, and thus aid in explaining the fact that spring and neap tides do not occur simultaneously with the syzygies and quadratures. This idea is at least as old as Daniel Bernoulli's essay on tides; but that philosopher hardly deemed it worthy of serious consideration.

Another error consists in assuming that credence is still given by tidal authorities to the notion that a tide wave travels around the earth from east to west following the moon. While Mr. Elson justly condemns this notion, his explanation amounts

to nothing save the admission of the undisputed fact that the tides are due to the disturbing force of the moon or sun.

He makes the unique assumption that, since a land mass may permanently raise the sea level along the shore above a height which it would otherwise occupy, the tides are due to the moon's tidal forces acting alternately with and against this constant attraction of the land mass upon the adjacent waters. How the permanent attraction of nearby-land masses comes into the periodic ebb and flow of the tide, is not made clear. This continental attraction is assumed to be lessened when the moon is on the meridian and to assume its undisturbed value when the moon is in the horizon. In other words, he imagines the vertical, rather than the horizontal, component of the moon's attraction to produce the tides, and that the vertical force vanishes when the moon is in the horizon; that these assumptions are errors, is too well known to require further notice.

Finally appeal is made to barometric readings for establishing the truth of this unique tidal hypothesis. He finds the greatest range of the barometer to occur soon after the time when the moon is near quadrature, and the least, soon after syzygy. This state of affairs may possibly exist at some places, because the atmospheric lunar tides are difficult to understand, and their small range, as measured by the barometer, renders them difficult to measure. But, according to observations made at Singapore, Batavia, and St. Helena the maximum height of the lunar fluctuation in the barometric pressure occurs when the moon is on the meridian or a little later. Now the large fluctuation in the barometer follows the period of the solar day, and, using the value given by Mr. Elson, the maximum height occurs at about 10 a. m. and 10 p. m. The maximum range should, therefore, occur on those days when the moon crosses the meridian at about 10 o'clock and not when she crosses the meridian at 6 or 7 o'clock, or on the days of neap tides.

On the whole, we think that Mr. Elson, who is well known in India, has not made his suggestions acceptable to those who have given much attention to the tides and tidal theories.—*R. A. H.*

METEOROLOGICAL COURSE AT WILLIAMS COLLEGE.

In the REVIEW for March, 1904, p. 517, we gave the first part of the syllabus of the course of lectures by Prof. Willis I. Milham, on meteorology, during the current year at Williams College. The rest of this syllabus will be equally helpful to those who are giving similar instruction at other colleges, and is published herewith from the manuscript that is given to the students as a synopsis of his method of treating the subject.—*C. A.*

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WEATHER PREDICTION.

CORRIGENDA.

The numbers of the charts "XXXIII–51, Chart XI," and "XXXIII–52, Chart XII," should be transposed.

THE WEATHER OF THE MONTH.

By Mr. P. C. DAY, Acting Chief, Division of Meteorological Records.

PRESSURE.

The distribution of mean atmospheric pressure is graphically shown on Chart VIII and the average values and departures from normal are shown in Tables I and V.

The normal distribution of atmospheric pressure over the United States and Canada for April shows well-marked transitional conditions from the winter types of pressure to those of summer. Over the north Pacific coast, and extending into British Columbia, the summer type of high pressure has become well established by the end of April; the low over the Southwest has intruded northward and eastward far into the Rocky Mountain and western plains region. The continental winter type of high pressure, covering the Rocky Mountains and western plains, has gradually drifted eastward and covers the region from the Lakes northward toward Hudson Bay and southward to the Gulf, the ridge of highest pressure lying between the meridians of 80° and 85° and diminishing by gentle gradients eastward and westward. This shifting of the positions of the areas of high and low pressure gives to New England and the States surrounding the Lakes, prevailing northerly winds, and winter conditions still predominate, but with much diminished energy.

Under the influence of the extensive low covering the southern Rocky Mountain region and extending into Texas, Oklahoma, and Kansas warm southerly winds prevail over this section and summer conditions are fairly well established.

Over the northern Rocky Mountain and north Pacific region under the influence of the high pressure approaching from the Pacific coast warm southerly winds prevail.

During the current month the interior high area receded from the advanced eastward position it occupied during March and the center of high pressure over the Dakotas was far to the west and north of its normal position.

The northward extension of the low over the Gulf of California was considerably retarded and the north Pacific high had intruded but slightly beyond the coast line of Washington and Oregon.

Over the entire eastern slope of the Rocky Mountains and from central Texas northward the pressure was above the normal.

East of the above limits the pressure was everywhere below the normal, attaining a maximum negative departure of from .15 to .25 of an inch over New England, eastern Ontario, Quebec, and the Maritime Provinces of Canada.

West of the Rocky Mountains the pressure was also lower than the average, except over extreme northwestern Washington.

The normal pressure for April shows a uniform reduction from that of March over the entire United States and Canada, except from central Oregon and Washington westward and northward into British Columbia, and over the St. Lawrence Valley, and Maritime Provinces of Canada, where slight increases are noted.

During the current month the pressure diminished from that of March throughout all sections, except over the upper Missouri Valley, the north Pacific coast, and the British Northwest Territories.

TEMPERATURE OF THE AIR.

As a result of the retardation of the eastward drift of the interior high pressure area, cool northerly winds prevailed south and east of the Dakotas, and temperatures were, therefore, below the normal from the Lakes southward to the Gulf and west to the Rocky Mountains and into New Mexico and Arizona.

North of the high pressure area southerly winds and temperatures above the normal prevailed as far north as the field of observation extends.

The average temperatures for the several geographic districts and the departures from the normal values are shown in the following table:

Average temperatures and departures from normal.

Districts.	Number of stations.	Average temperatures for the current month.	Departures for the current month.	Accumulated departures since January 1.	Average departures since January 1.
		°	°	°	°
New England	8	43.3	+ 0.4	− 7.7	−1.9
Middle Atlantic	12	51.3	+ 0.9	− 7.9	−2.0
South Atlantic	10	62.4	+ 0.5	− 8.6	−2.2
Florida Peninsula *	8	71.2	+ 0.7	− 1.6	−0.4
East Gulf	9	65.4	− 0.4	−11.6	−2.9
West Gulf	7	65.9	− 1.1	−11.0	−2.8
Ohio Valley and Tennessee	11	54.8	− 0.6	−11.1	−2.8
Lower Lake	8	43.5	− 1.2	−10.0	−2.5
Upper Lake	10	40.7	+ 0.2	− 5.3	−1.3
North Dakota *	8	40.6	− 1.1	+ 8.3	+2.1
Upper Mississippi Valley	11	50.4	− 0.8	− 7.6	−1.9
Missouri Valley	11	49.4	− 1.5	− 4.7	−1.2
Northern Slope	7	43.3	− 1.3	+ 2.9	+0.7
Middle Slope	6	51.4	− 2.8	− 8.7	−2.2
Southern Slope *	6	57.0	− 3.5	−14.8	−3.7
Southern Plateau *	13	54.5	− 2.0	+ 3.0	+0.8
Middle Plateau *	8	47.6	+ 0.5	+ 9.2	+2.3
Northern Plateau *	12	48.5	+ 1.9	+10.6	+2.6
North Pacific	7	51.2	+ 2.6	+10.7	+2.7
Middle Pacific	5	57.2	+ 1.7	+10.3	+2.6
South Pacific	4	59.4	+ 0.7	+11.5	+2.9

* Regular Weather Bureau and selected cooperative stations.

In Canada.—Prof. R. F. Stupart says:

The temperature ranged from average to 1° and 2° below over the greater portion of Ontario, while elsewhere over the Dominion it was very generally above the average, the most pronounced positive departures being from 3° to 5° in parts of Quebec and New Brunswick, 3° in the northern portions of Alberta and Saskatchewan, 3° on Vancouver Island, and as much as 7° in Cariboo.

West of the Rocky Mountains and north of New Mexico and Arizona temperatures were generally from 2° to 3° above the normal. On the Atlantic coast also the temperature averaged slightly above the normal.

Abnormally cold weather occurred over practically all the territory east of the Rocky Mountains during the progress eastward of the high pressure area from the 14th to the 18th, carrying the line of freezing temperature into the northern parts of Mississippi, Alabama, and Georgia, the central part of South Carolina, and almost to the coast of North Carolina. No severe cold occurred west of the Rocky Mountains.

Temperatures as low as zero were reported from a few elevated points in the central Rocky Mountain district.

Maximum temperatures of 90°, or above, occurred over Florida and southern Georgia, extreme southern Texas, eastern Kansas, Oklahoma and Indian Territories, southern and western Arizona, and southeastern California.

PRECIPITATION.

The distribution of total monthly precipitation is shown on Chart III.

The normal rainfall for April is well distributed over all sections east of the Rocky Mountains, falling below two inches at a few isolated points only and rising above four inches over a comparatively small area in the lower Mississippi Valley.

On the Pacific slope comparatively heavy precipitation still prevails west of the Coast Range of mountains from northern California northward.

During the current month the precipitation was comparatively heavy over the central parts of North and South Carolina, eastern Georgia, the lower Mississippi Valley, Texas, the entire slope region from Nebraska and Wyoming southward, including Utah, and most points in New Mexico and Arizona.

In parts of central Louisiana, southern Arkansas, and central Texas the monthly fall exceeded ten inches. Over southeastern Wyoming, the western parts of Nebraska, Kansas, Oklahoma, and Texas, and in portions of New Mexico, Arizona, and Colorado the fall exceeded four inches.

At Phoenix, Ariz., and El Paso, Tex., the fall exceeded that for any preceding April since the beginning of observations at those points.

From the Lake region westward, including the upper Mississippi and Missouri valleys, the northern slope, the greater part of the Plateau region, and the entire Pacific slope the precipitation was much below normal.

At St. Paul, Minn., Bismarck and Williston, N. Dak., Roseburg, Oreg., and Eureka, Cal., the amounts for the current month were less than those recorded in any preceding April.

In a narrow area from southern Indiana to the Gulf the precipitation was also markedly deficient; at Nashville, Tenn., the amount recorded, 1.5 inches, being nearly 1.0 inch less than that of any preceding April.

The precipitation was generally well distributed throughout the month, and even in sections where the total amount was small, light showers were frequent.

Heavy rains occurred over southern Florida on the 21st; over the Gulf States on the 2d to 4th, inclusive, 24th, 25th, 29th, and 30th; in the Mississippi Valley on the 20th and 25th; and from southern Wyoming southward to the panhandle of Texas, and over New Mexico and Arizona, on the 19th, 20th, 23d, and 24th.

Snowfall.—The snowfall during the month was abnormally heavy over the southern Rocky Mountain region, and, with the heavy rainfall in addition, the ground at the end of the month was thoroughly soaked, the rivers were bank full of water, and the visible supply ample for all irrigation purposes.

Snow occurred over a large extent of the entire country, but was generally light, except in the territory indicated above.

Average precipitation and departure from the normal.

Districts.	Number of stations.	Average.		Departure.	
		Current month.	Percentage of normal.	Current month.	Accumulated since Jan. 1.
		Inches.		*Inches.*	*Inches.*
New England	8	1.88	61	−1.2	−4.0
Middle Atlantic	12	2.69	84	−0.5	−2.1
South Atlantic	10	3.74	119	+0.4	−2.0
Florida Peninsula*	8	2.62	113	+0.3	+0.3
East Gulf	9	4.56	96	−0.2	+0.7
West Gulf	7	6.59	169	+2.7	+1.7
Ohio Valley and Tennessee	11	2.97	75	−1.0	−4.6
Lower Lake	8	2.58	108	+0.2	−2.0
Upper Lake	10	1.94	83	−0.4	−1.3
North Dakota*	8	0.41	21	−1.5	−2.2
Upper Mississippi Valley	11	2.22	76	−0.7	−2.2
Missouri Valley	11	2.22	76	−0.7	−0.5
Northern Slope	7	2.33	143	+0.7	+0.4
Middle Slope	6	3.88	178	+1.7	+3.2
Southern Slope*	6	4.32	186	+2.0	+4.3
Southern Plateau*	13	1.98	495	+1.5	+6.0
Middle Plateau*	8	1.40	140	+0.4	+1.1
Northern Plateau*	12	0.92	75	−0.3	−1.6
North Pacific	7	1.17	28	−3.0	−7.3
Middle Pacific	5	1.00	37	−1.7	−2.7
South Pacific	4	0.47	34	−0.9	+2.3

*Regular Weather Bureau and selected cooperative stations.

In Canada.—Professor Stupart says:

The precipitation was slightly above the average in sections of the interior of British Columbia, while in all other portions of the Dominion the average was not maintained, except at Swift Current in Assiniboia, where it was slightly exceeded. The negative departures were as a rule pronounced—this was especially the case in Manitoba, where the deficiency was generally more than an inch, likewise in the Maritime Provinces, where it was from one to three inches. In Ontario the deficiency was usually from half an inch to an inch and in the Northwest Territories about half an inch. A few snowfalls were experienced in all the Provinces, but no heavy falls were recorded, if we except the snowstorm of the 28th in the Northwest Territories which, however, was confined to a limited area.

HUMIDITY.

Over the Florida Peninsula and the Gulf States the relative humidity exceeded the normal and also over the entire Rocky Mountain section. Over the middle and southern slope and southern Plateau the normal was exceeded by from 10 to 20 per cent.

The averages by districts appear in the following table:

Average relative humidity and departures from the normal.

Districts.	Average.	Departure from the normal.	Districts.	Average.	Departure from the normal.
	%			%	
New England	69	−4	Missouri Valley	65	0
Middle Atlantic	66	−1	Northern Slope	65	+6
South Atlantic	72	0	Middle Slope	67	+10
Florida Peninsula	76	+2	Southern Slope	65	+13
East Gulf	76	+6	Southern Plateau	52	+22
West Gulf	75	+3	Middle Plateau	54	+7
Ohio Valley and Tennessee	65	0	Northern Plateau	57	+1
Lower Lake	70	0	North Pacific	73	−4
Upper Lake	72	−1	Middle Pacific	71	−1
North Dakota	62	−6	South Pacific	73	+5
Upper Mississippi Valley	68	0			

CLEAR SKY AND CLOUDINESS.

The amount of cloudiness during the month was in excess of the normal over all sections, except from the upper Mississippi Valley westward to the Pacific.

The distribution of clear sky is graphically shown on Chart IV, and the numerical values of average daylight cloudiness, both for individual stations and by geographic districts, appear in Table I.

The average for the various districts, with departures from the normal, are shown in the following table:

Average cloudiness and departures from the normal.

Districts.	Average.	Departure from the normal.	Districts.	Average.	Departure from the normal.
New England	5.5	+ 0.2	Missouri Valley	5.5	+ 0.1
Middle Atlantic	5.4	+ 0.2	Northern Slope	5.4	0.0
South Atlantic	4.6	+ 0.2	Middle Slope	5.8	+ 1.4
Florida Peninsula	4.7	+ 0.8	Southern Slope	4.6	+ 0.4
East Gulf	5.5	+ 1.0	Southern Plateau	3.7	+ 1.3
West Gulf	5.6	+ 0.4	Middle Plateau	5.0	+ 0.5
Ohio Valley and Tennessee	5.8	+ 0.5	Northern Plateau	5.6	— 0.7
Lower Lake	6.0	+ 0.5	North Pacific	5.2	— 1.2
Upper Lake	6.0	+ 0.3	Middle Pacific	4.1	— 0.7
North Dakota	4.5	— 1.0	South Pacific	5.4	+ 1.5
Upper Mississippi Valley	5.2	— 0.3			

WIND.

The maximum wind velocity at each Weather Bureau station for a period of five minutes is given in Table I, which also gives the altitude of Weather Bureau anemometers above ground.

Following are the velocities of 50 miles and over per hour registered during the month:

Maximum wind velocities.

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
Chicago, Ill.	29	58	w.	Mount Tamalpais, Cal.	11	50	ne.
Cleveland, Ohio	16	52	nw.	Do	22	53	nw.
Do	17	51	nw.	Do	29	54	nw.
Columbus, Ohio	10	56	nw.	Do	30	60	nw.
Eastport, Me.	6	60	se.	New York, N. Y.	10	56	w.
Hatteras, N. C.	16	52	n.	Do	21	54	w.
Havana, Cuba	20	51	e.	Pittsburg, Pa.	10	60	w.
Lexington, Ky.	10	56	sw.	Pueblo, Colo.	20	51	ne.
Memphis, Tenn.	11	50	nw.	Sioux City, Iowa	3	54	n.
Do	29	52	w.	Tatoosh Island, Wash.	3	52	e.
Modena, Utah	18	50	w.	Taylor, Tex.	23	50	nw.
Mount Tamalpais, Cal.	1	57	nw.	Williston, N. Dak.	28	50	w.

DESCRIPTION OF TABLES AND CHARTS.

By Mr. WM. B. STOCKMAN, Chief, Division of Meteorological Records.

For description of tables and charts see page 20 of REVIEW for January, 1905.

Table I.—*Climatological data for U. S. Weather Bureau stations, April, 1905.*

Stations.	Elevation of instruments.			Pressure, in inches.			Temperature of the air, in degrees Fahrenheit.												Precipitation, in inches.			Wind.									
	Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.	Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hrs.	Departure from normal.	Mean max. + mean min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Total.	Departure from normal.	Days with .01, or more.	Total movement, miles.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.
New England.							43.3	+ 0.4										69	1.83	— 1.2										5.5	
Eastport	76	69	82	29.69	29.77	— .16	39.4	+ 0.8	67	26	46	22	2	32	26	36	32	77	0.83	— 2.2	4	8,240	sw.	60	se.	6	2	18	10	6.5	0.4
Portland, Me.	103	81	117	29.70	29.82	— .14	42.2	— 0.8	72	26	50	25	2	35	27	37	30	64	1.43	— 1.6	9	7,352	nw.	39	w.	1	8	10	12	5.9	T.
Concord	288	70	79	29.51	29.82	— .17	43.6	— 0.7	73	26	54	25	2	33	35	...	...	...	1.66	— 1.2	10	4,854	nw.	27	nw.	1	6	16	8	5.8	T.
Northfield	876	16	60	28.88	29.84	— .15	39.4	+ 0.1	69	26	49	22	2	30	38	35	29	66	1.93	— 0.1	11	7,414	s.	38	nw.	1	6	11	13	6.3	3.4
Boston	125	115	181	29.70	29.84	— .13	46.8	+ 1.7	74	26	55	30	2	38	28	41	34	66	2.14	— 1.3	9	8,265	w.	38	w.	17	8	12	10	5.1	T.
Nantucket	12	14	90	29.83	29.84	— .13	43.9	+ 0.8	64	30	49	32	2	38	21	41	38	85	1.57	— 2.0	12	13,054	sw.	47	sw.	21	7	16	7	5.4	T.
Block Island	26	11	46	29.83	29.86	— .12	43.8	+ 0.4	60	30	49	33	3	38	19	39	35	77	2.10	— 1.3	13	12,554	sw.	42	w.	17	8	13	9	5.4	0.1
Providence	159	57	67	29.68	29.86	— .12	46.8	...	72	26	57	28	3	37	30	39	31	61	3.09	...	10	5,884	w.	28	w.	17	12	11	7	5.3	T.
Hartford	159	115	132	29.69	29.86	— .13	47.6	...	73	27	57	29	19	38	28	40	32	61	2.57	...	9	6,026	nw.	31	s.	20	11	11	8	4.9	0.1
New Haven	106	116	154	29.76	29.87	— .12	47.3	+ 1.2	68	30	56	30	19	39	27	41	35	66	3.42	— 0.1	9	7,244	nw.	34	w.	17	14	10	6	4.2	T.
Mid. Atlantic States.							51.3	+ 0.9										66	2.69	— 0.5										5.4	
Albany	97	102	115	29.76	29.87	— .13	46.4	+ 0.4	74	27	56	30	3	37	32	40	33	66	2.12	— 0.4	12	5,987	s.	30	se.	29	7	13	10	6.1	2.0
Binghamton	875	79	90	28.96	29.90	— .12	44.0	— 1.5	76	28	54	23	3	34	38	...	...	...	2.01	— 0.3	12	4,899	nw.	27	w.	21	8	9	13	6.1	2.9
New York	314	108	350	29.54	29.88	— .12	49.8	+ 1.7	76	21	58	31	17	42	28	44	38	69	2.45	— 0.9	13	8,629	nw.	56	w.	10	10	11	9	5.5	T.
Harrisburg	374	94	104	29.51	29.91	— .11	51.2	+ 1.1	74	21	60	31	19	42	30	44	35	59	1.39	— 2.1	10	5,594	nw.	36	w.	17	9	11	10	5.7	T.
Philadelphia	117	116	184	29.78	29.90	— .11	52.6	+ 2.1	79	21	61	33	19	44	31	44	36	58	3.58	+ 0.6	13	8,011	nw.	40	w.	21	8	11	11	5.7	T.
Scranton	805	111	119	29.03	29.90	— .11	47.8	...	78	28	58	26	3	37	35	42	37	72	1.93	...	13	5,895	sw.	44	w.	10	7	6	17	6.6	4.8
Atlantic City	52	39	48	29.85	29.91	— .09	48.0	+ 1.2	72	30	55	29	3	41	24	43	39	74	3.51	+ 0.2	11	6,321	sw.	24	ne.	13	8	11	11	5.7	T.
Cape May	17	48	52	29.91	29.93	— .06	49.3	+ 1.1	70	25	56	32	3	43	25	45	...	...	3.46	+ 0.3	10	6,768	s.	30	nw.	16	7	18	5	5.2	T.
Baltimore	123	69	117	29.78	29.91	— .10	54.2	+ 1.1	81	21	64	33	19	45	34	46	39	61	3.07	— 0.4	12	5,697	nw.	36	w.	17	8	5	17	6.4	T.
Washington	112	59	76	29.79	29.91	— .11	54.0	+ 1.0	82	21	64	29	19	44	35	47	41	67	2.69	— 0.6	13	5,507	nw.	30	nw.	17	8	13	9	5.4	T.
Lynchburg	681	83	88	29.18	29.92	— .10	56.8	+ 0.9	88	29	68	30	19	45	45	49	43	66	2.33	— 1.0	10	3,746	nw.	26	nw.	7	8	17	5	5.0	T.
Mount Weather	1,725	10	57	28.09	29.91	— .11	49.6	...	77	10	58	25	17	41	34	44	38	69	2.31	...	13	12,125	nw.	46	nw.	16	10	12	8	4.9	1.0
Norfolk	91	102	111	29.84	29.94	— .07	56.6	+ 0.4	85	11	66	35	17	47	33	50	44	68	3.88	— 0.2	10	7,526	s.	34	sw.	11	14	9	7	4.6	
Richmond	144	82	90	29.80	29.95	— .07	57.6	...	85	11	68	33	17	47	35	...	...	...	3.06	...	12	5,064	sw.	30	s.	21	16	11	3	3.6	T.
Wytheville	2,293	40	47	27.55	29.92	— .11	52.4	+ 0.8	76	1	64	26	19	41	40	45	40	69	1.77	— 1.3	10	4,546	nw.	25	nw.	16	12	11	7	4.9	0.1
S. Atlantic States.							62.4	+ 0.5										72	3.74	+ 0.4										4.6	
Asheville	2,255	53	75	27.60	29.94	— .09	54.9	+ 0.4	81	10	65	28	7	44	38	48	43	70	3.11	0.0	12	6,054	nw.	36	nw.	16	7	10	13	6.3	0.5
Charlotte	773	68	76	29.11	29.95	— .08	60.3	+ 0.6	82	1	71	33	17	50	33	52	46	67	2.72	— 0.8	11	5,822	sw.	36	w.	7	10	15	5	4.5	
Hatteras	11	12	47	29.94	29.95	— .06	59.0	+ 1.8	74	4	65	41	17	53	22	55	52	80	4.17	— 0.6	8	11,705	sw.	52	n.	16	18	6	6	3.8	
Raleigh	376	71	79	29.53	29.94	— .09	59.1	+ 0.3	87	29	70	32	17	48	33	52	45	66	5.03	+ 1.8	8	5,404	sw.	32	nw.	16	16	10	4	3.4	T.
Wilmington	78	82	90	29.86	29.94	— .09	61.0	— 0.5	83	29	70	36	17	52	31	55	51	77	4.80	+ 1.8	9	6,775	sw.	29	w.	6	11	15	4	4.5	
Charleston	48	14	92	29.92	29.97	— .06	63.8	+ 1.2	85	29	73	39	17	58	23	59	56	78	2.30	— 1.3	7	8,267	s.	37	s.	27	14	12	4	4.0	
Columbia, S. C.	351	41	57	29.57	29.95	— .08	63.6	0.0	85	28	74	32	17	53	35	55	50	69	7.51	+ 4.7	10	5,620	sw.	36	sw.	9	8	16	6	5.5	
Augusta	180	89	97	29.77	29.96	— .07	64.4	+ 0.2	88	28	75	34	17	54	35	56	51	70	4.50	+ 1.2	13	5,207	s.	36	nw.	6	10	15	5	4.3	
Savannah	65	81	89	29.91	29.98	— .05	67.0	— 0.9	90	29	76	40	17	58	26	59	54	72	1.29	— 2.2	9	6,507	w.	32	w.	27	8	12	10	5.4	
Jacksonville	43	101	129	29.93	29.98	— .06	68.7	— 0.2	88	29	78	43	17	61	22	62	58	74	2.02	— 0.8	5	8,072	sw.	40	sw.	5	16	7	7	4.2	
Florida Peninsula.							72.7	— 0.4										76	2.91	+ 0.8										4.7	
Jupiter	28	10	48	29.96	29.99	— .05	73.0	— 1.0	89	27	80	54	7	66	21	67	64	76	3.14	+ 0.4	7	8,917	se.	42	w.	21	7	18	5	5.2	
Key West	22	10	53	29.96	29.98	— .04	74.3	— 1.8	86	28	79	64	7	70	14	69	66	78	3.71	+ 2.5	8	7,832	e.	48	nw.	12	15	7	8	4.5	
Tampa	34	79	96	29.95	29.99	— .07	70.8	— 0.3	87	30	79	47	18	62	29	63	60	74	1.89	— 0.4	6	6,438	w.	34	w.	12	12	12	6	4.4	
East Gulf States.							65.4	— 0.3										76	4.56	— 0.2										5.5	
Atlanta	1,174	190	216	28.73	29.96	— .07	61.4	— 0.2	86	28	70	31	17	52	29	54	50	73	2.75	— 1.6	12	9,636	s.	44	nw.	16	2	18	10	6.3	
Macon	370	93	99	29.58	29.97	— .06	64.4	...	88	28	75	35	7	54	34	...	...	...	2.69	...	13	5,027	nw.	34	n.	29	8	6	16	6.2	
Pensacola	56	79	96	29.93	29.99	— .03	67.1	— 0.6	82	27	73	45	6	62	20	...	...	...	3.38	— 0.1	7	8,810	sw.	42	nw.	12	13	6	11	4.8	
Birmingham	700	136	143	29.20	29.96	— .06	62.6	— 1.6	84	28	72	33	17	54	30	...	...	...	4.04	— 2.2	16	6,734	sw.	30	nw.	6	8	10	12	5.8	
Mobile	57	88	96	29.91	29.97	— .05	67.7	— 0.8	89	27	75	43	6	60	25	62	59	78	2.53	— 2.2	8	6,134	s.	38	se.	25	9	16	5	4.9	
Montgomery	223	100	112	29.73	29.98	— .05	65.6	+ 0.2	86	27	75	39	17	56	33	59	55	74	1.76	— 3.0	8	5,867	sw.	24	w.	5	9	13	8	5.0	
Meridian	375	84	93	29.56	29.96	— .06	64.0	— 1.6	84	10	74	36	17	54	38	...	...	...	7.43	+ 3.1	12	4,864	sw.	36	se.	10	13	12	5	4.5	
Vicksburg	247	62	74	29.67	29.95	— .05	65.2	— 0.6	84	27	74	41	6	56	32	59	55	76	8.70	+ 2.8	15	5,942	sw.	35	se.	24	7	9	14	6.6	
New Orleans	51	88	121	29.90	29.95	— .05	69.4	+ 0.4	87	28	77	48	6	62	25	63	60	78	5.89	+ 0.7	8	7,438	sw.	36	nw.	5	11	10	9	5.1	
West Gulf States.							65.9	— 1.1										75	6.59	+ 2.7										5.6	
Shreveport	249	77	84	29.66	29.93	— .04	65.0	— 1.4	89	28	74	44	6	56	31	59	55	75	10.97	+ 5.8	14	5,661	se.	34	nw.	14	10	6	14	5.7	
Fort Smith	457	79	94	29.43	29.91	— .05	61.2	— 1.0	90	27	70	41	6	52	40	54	48	67	3.95	— 1.1	10	6,841	e.	42	nw.	10	6	16	8	5.2	
Little Rock	357	93	100	29.56	29.93	— .05	62.4	— 0.8	86	27	70	39	5	55	35	55	50	69	7.72	+ 3.0	15	6,284	s.	35	nw.	5	11	6	13	5.7	
Corpus Christi	20	48	53	29.88	29.90	— .05	70.6	— 0.7	84	14	76	49	5	65	25	66	64	83	3.30	+ 1.7	7	8,660	se.	39	se.	23	4	11	15	6.4	
Fort Worth	670	106	114	29.21	29.92	— .02	62.0	...	88	8	72	36	16	52	34	...	...	...	7.73	...	9	8,833	s.	38	e.	24	15	5	10	4.8	
Galveston	54	106	112	29.87	29.93	— .04	69.7	+ 0.1	80	27	74	50	5	65	15	66	64	85	7.62	+ 4.7	9	9,493	s.	43	nw.	29	9	8	13	5.7	
Palestine	510	73	79	29.38	29.91	— .05	65.2	— 1.5	85	28	74	42	5	56	32	59	55	75	6.51	+ 1.9	13	6,593	s.	30	s.	8	8	9	13	5.9	
San Antonio	701	80	91	29.16	29.88	— .05	67.4	— 2.7	87	28	78	43	5	57	33	60	56	71	6.08	+ 3.1	8	5,413	se.	40	nw.	11	10	9	11	5.3	
Taylor	583	55	63	29.29	29.90	— .05	65.8	...	86	28	76	41	16	56	37	...	...	...	7.41	...	8	7,705	n.	50	nw.	23	7	9	14	6.1	
Ohio Val. and Tenn.							54.8	— 0.6										65	2.97	— 1.0										5.8	
Chattanooga	762	106	112	29.16	29.97	— .06	60.6	— 0.3	84	28	71	33	17	51	32	53	47	65	2.83	— 1.7	12	5,774	sw.	39	nw.	6	4	13	13	6.5	0.2
Knoxville	1,004	35	88	28.89	29.94	— .09	57.6	— 0.6	83	10	68	31	17	47	36	50	45	68	4.36	— 0.6	14	6,100	sw.	42	w.	10	7	8	15	6.5	T.
Memphis	399	76	97	29.54	29.96	— .04	61.6	— 0.5	82	28	70	39	17	54	29	54	48	67	5.83	+ 0.3	14	7,580	sw.	52	w.	29	10	6	14	5.5	
Nashville	546	122	134	29.38	29.97	— .04	59.0	— 0.8	85	28	69	33	17	49	33	51	44	62	1.50	— 3.3	10	6,085	nw.	39	sw.	8	10	10	10	5.7	T.
Lexington	989	75	102	28.87	29.94	— .08	53.8	— 2.1	82	28	63	26	16	44	30	...	...	...	2.87	— 0.8	11	8,814	nw.	56	sw.	10	9	17	4	4.4	1.3
Louisville	525	114	136	29.37	29.95	— .06	56.9	+ 0.5	85	28	67	30	16	47	35	48	41	61	2.14	— 2.3	9	6,917	w.	34	sw.	20	6	8	16	6.4	0.4
Evansville	431	72	82	29.47	29.94	— .06	56.6	...	83	2	65	33	16	48	30	...	...	...	3.46	...	9	6,104	nw.	38	sw.	20	8	19	3	5.0	0.1
Indianapolis	822	154	164	29.04	29.93	— .07	51.8	— 1.1	80	28	61	30	16	43	34	45	39	66	2.70	— 1.0	9	7,280	nw.	38	s.	3	6	6	18	6.5	T.
Cincinnati	628	152	160	29.26	29.93	— .08	54.3	— 0.3	81	10	64	29	8	45	32	46	39	59	3.14	— 0.1	11	5,100	w.	29	sw.	20	8	10	12	6.0	0.2
Columbus	824	173	190	29.05	29.93	— .09	50.4	— 0.8	80	10	60	28	8	40	35	45	40	72	3.15	0.0	10	8,473	sw.	56	nw.	10	7	12	11	5.8	0.4
Pittsburg	842	336	352	29.02	29.93	— .09	50.6	— 0.6	77	28	61	27	17	40	34	43	35	60	2.07	— 0.7	16	7,578	nw.	60	w.	10	8	13	9	5.8	0.7
Parkersburg	638	77	84	29.27	29.93	— .10	52.9	— 0.9	83	10	64	30	16	42	39	45	39	66	2.13	— 0.8	11	4,564	nw.	44	nw.	10	11	11	8	4.7	T.
Elkins	1,940	41	50	27.88	29.95	— .08	48.4	+ 0.3	81	10	61	23	19	36	47	42	37	73	2.96	— 0.6	15	3,470	w.	24	sw.	10	6	10	14	6.3	3.8
Lower Lake Region.							43.5	— 1.2										70	2.58	+ 0.2										6.0	
Buffalo	767	178	206	29.06	29.90	— .11	41.0	— 0.7	72	28	48	26	17	34	34	36	31	71	2.38	— 0.1	13	9,695	sw.	45	nw.	17	7	9	14	6.2	3.2
Oswego	335	76	91	29.51	29.88	— .13	40.8	— 1.5	74	28	48	27	3	34	36	37	32	72	2.79	+ 0.7	9	7,791	w.	31	nw.	17	7	12	11	5.8	0.4
Rochester	523	81	102	29.32	29.90	— .11	43.6	+ 0.1	74	28	52	25	16	35	30	37	30	64	1.76	— 0.7	10	6,927	w.	37	sw.	19	8	9	13	6.1	0.5
Syracuse	597	97	113	29.24	29.88	— .13	43.2	...	75	28	51	25	3	35	33	...	...	...	2.41	...	11	9,667	nw.	45	w.	17	5	14	11	6.1	2.0
Erie	713	92	102	29.14	29.91	— .11	43.6	— 0.5	73	28	51	28	8	36	33	38	32	65	2.29	— 0.2	11	7,386	w.	33	w.	29	3	14	13	6.8	1.0
Cleveland	762	190	201	29.10	29.93	— .09	44.0	— 1.7	74	28	51	29	16	37	33	42	39	81	2.38	+ 0.1	14	10,414	nw.	52	nw.	16	7	12	11	5.8	0.7
Sandusky	629	62	70	29.23	29.91	— .11	45.0	— 2.0	75	28	52	26	8	38	35	...	...	...	3.59	+ 1.1	12	6,485	sw.	42	nw.	16	9	9	12	5.5	T.
Toledo	628	120	127	29.24	29.93	— .08	45.6	— 1.9	75	28	54	25	8	37	34	40	34	67	3.23	+ 1.0	12	7,480	w.	36	sw.	4	10	10	10	5.2	2.3
Detroit	730	153	193	29.12	29.91	— .11	44.4	— 1.3	72	28	52	27	16	36	31	39	33	67	2.20	0.0	12	8,420	w.	38	sw.	4	7	9	14	6.3	0.3
Upper Lake Region.							40.7	+ 0.2										72	1.94	— 0.4										6.0	
Alpena	609	63	80	29.22	29.90	— .12	40.2	+ 3.1	72	28	49	25	7	32	33	36	32	76	1.58	— 0.6	10	8,077	nw.	38	w.	19	7	12	11	6.1	1.0
Escanaba	612	40	48	29.24	29.92	— .10	37.3	+ 1.5	63	19	45	20	18	30	26	33	28	71	2.00	— 0.1	8	5,285	n.	26	n.	16	9	9	12	5.9	10.5
Grand Rapids	707	127	165	29.14	29.92	— .09	44.8	— 2.2	78	28	53	26	18	36	27	39	34	70	2.23	0.0	11	8,294	nw.	40	w.	4	7	14	9	5.9	1.7
Houghton	668	66	74	29.17	29.91	— .11	37.6	...	72	25	45	25	8	30	42	...	...	...	1.97	...	15	5,395	nw.	27	n.	3	13	9	8	5.2	9.8
Marquette	734	76	116	29.11	29.92	— .10	37.0	— 0.2	66	25	44	21	18	30	30	32	26	69	1.22	— 0.8	12	7,847	nw.	32	s.	23	6	7	17	6.8	6.0
Port Huron	638	70	120	29.23	29.94	— .08	41.5	— 0.2	72	28	50	23	8	33	33	37	32	72	1.65	— 0.5	9	8,479	ne.	39	sw.	4	9	4	17	6.3	0.9
Sault Ste. Marie	614	40	61	29.20	29.91	— .12	35.9	— 1.8	67	26	43	21	18	29	37	31	27	75	1.70	+ 0.1	7	7,482	nw.	34	nw.	16	10	10	10	5.5	1.1
Chicago	823	241	274	29.04	29.94	— .06	45.5	— 0.1	77	28	52	30	16	39	38	40	37	77	3.03	0.0	12	11,362	ne.	58	w.	29	6	15	9	5.8	0.2
Milwaukee	681	124	142	29.19	29.94	— .05	43.5	+ 0.8	76	28	51	27	7	36	31	38	34	73	2.00	— 0.9	12	7,917	n.	38	n.	21	8	9	13	6.3	3.4
Green Bay	617	49	86	29.24	29.91	— .10	43.2	+ 0.2	69	28	52	25	7	34	31	37	32	70	2.04	— 0.5	10	7,640	ne.	37	ne.	21	5	8	17	6.9	2.5
Duluth	1,133	11	47	28.70	29.94	— .07	38.2	+ 1.2	70	25	47	18	15	29	34	32	24	63	1.97	— 0.4	5	9,720	nw.	39	nw.	9	9	11	10	5.6	T.

TABLE I.—*Climatological data for U. S. Weather Bureau stations, April, 1905*—Continued.

Stations.	Elevation of instruments.			Pressure, in inches.			Temperature of the air, in degrees Fahrenheit.												Precipitation, in inches.			Wind.									
	Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.	Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hrs.	Departure from normal.	Mean max. + mean min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Total.	Departure from normal.	Days with .01, or more.	Total movement, miles.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.
North Dakota.							40.1	— 1.9										62	0.54	— 1.4										4.5	
Moorhead	935	8	57	28.97	30.01	+ .02	40.1	— 1.2	76	26	52	18	13	28	43	35	29	72	1.50	— 0.7	5	6,560	nw.	33	nw.	9	12	9	9	5.1	0.4
Bismarck	1,674	16	29	28.22	30.04	+ .07	40.7	— 1.4	75	7	54	17	16	27	46	34	26	59	0.07	— 2.2	1	7,473	nw.	40	w.	28	12	12	6	4.8	T.
Devils Lake	1,482	11	44	28.40	30.00	+ .01	38.4	....	74	25	51	14	13	25	43	33	26	67	0.10	....	5	8,349	nw.	46	w.	28	14	6	10	4.5	0.7
Williston	1,875	14	44	27.98	30.00	+ .04	39.6	— 3.0	80	26	56	3	16	23	46	32	20	51	0.04	— 1.4	2	7,673	ne.	50	w.	28	15	11	4	3.7	T.
Upper Miss. Valley.							50.4	— 0.8										68	2.22	— 0.7										5.2	
Minneapolis	......	102	208	....	....	....	44.0	— 3.1	72	25	53	21	7	35	28	....	....	...	0.74	— 2.0	4	9,607	nw.	33	n.	3	11	5	14	5.9	T.
St. Paul	837	171	179	29.01	29.93	— .06	44.8	— 0.4	69	24	53	24	14	36	26	38	30	59	0.30	— 2.2	4	8,699	n.	37	n.	3	11	10	9	4.7	T.
La Crosse	714	71	87	29.16	29.94	— .04	46.4	— 1.0	72	24	55	25	7	38	31	....	....	...	0.62	— 1.6	10	6,075	n.	28	n.	3	10	9	11	5.2	0.3
Madison	974	70	78	28.86	29.92	— .07	44.8	....	72	28	53	25	7	36	33	39	33	70	1.43	— 1.0	12	8,139	nw.	42	ne.	21	8	16	6	5.4	2.6
Charles City	1,015	8	58	28.85	29.94	— .04	44.6	....	72	1	55	18	14	34	33	40	35	73	1.99	— 0.6	7	6,474	nw.	32	nw.	4	8	11	11	5.8	1.0
Davenport	606	71	79	29.25	29.92	— .06	49.8	+ 0.1	82	9	59	28	16	40	36	43	37	66	3.45	+ 0.7	12	6,109	nw.	36	nw.	29	12	11	7	5.0	T.
Des Moines	861	84	99	29.04	29.95	— .02	48.7	— 1.8	82	9	59	21	16	39	36	42	35	66	3.29	+ 0.5	11	6,554	nw.	31	ne.	13	8	13	9	5.8	2.2
Dubuque	698	100	117	29.18	29.94	— .04	48.2	— 0.4	73	9	57	29	7	39	32	42	34	64	3.07	+ 0.3	12	5,685	nw.	32	ne.	20	9	8	13	6.0	0.2
Keokuk	614	63	78	29.24	29.92	— .06	52.6	+ 0.6	86	9	63	28	16	42	42	45	40	72	3.32	+ 0.1	8	6,390	nw.	36	w.	10	16	8	6	4.1	1.0
Cairo	356	87	93	29.56	29.95	— .04	58.2	— 0.7	86	28	67	35	17	50	30	53	48	72	2.19	— 1.7	10	7,371	sw.	41	nw.	28	5	12	13	6.6	T.
La Salle	536	56	64	29.37	29.94	— .05	49.6	....	81	9	60	28	16	39	43	....	....	....	3.71	....	11	6,691	w.	36	w.	29	13	12	5	3.8	0.9
Peoria	609	11	45	29.28	29.94	— .05	50.5	....	82	9	61	28	7	40	43	....	....	....	3.99	....	9	7,757	nw.	42	nw.	10	15	10	5	4.0	0.5
Springfield, Ill	644	82	93	29.23	29.92	— .06	52.6	— 0.8	85	9	63	30	16	42	39	45	39	67	2.02	— 1.7	9	7,564	w.	29	s.	3	13	9	8	4.9	0.4
Hannibal	534	75	109	29.34	29.92	— .06	53.2	— 0.5	90	9	64	29	17	43	45	....	....	....	4.07	+ 1.3	8	6,315	w.	43	sw.	28	11	12	7	4.8	T.
St. Louis	567	208	217	29.32	29.92	— .06	55.8	— 0.4	88	9	65	32	16	47	35	49	43	66	2.32	— 1.5	11	8,554	se.	38	n.	28	7	11	12	5.6	
Missouri Valley.							49.4	— 1.5										65	2.22	— 0.7										5.5	
Columbia, Mo	784	11	84	29.07	29.91	— .07	54.3	— 2.1	90	9	67	26	17	42	44	....	....	....	2.65	— 0.3	12	6,958	nw.	40	s.	28	14	7	9	4.5	0.2
Kansas City	963	78	95	28.91	29.95	— .01	55.0	+ 0.6	88	9	65	30	16	45	35	47	40	64	2.04	— 0.9	11	6,068	nw.	41	sw.	20	15	7	8	4.5	1.2
Springfield, Mo	1,324	98	104	28.52	29.92	— .05	55.8	— 1.7	87	9	65	31	16	46	31	49	44	71	3.25	— 0.6	11	8,219	s.	48	sw.	20	16	9	5	4.0	T.
Topeka	......	85	89	....	....	.....	54.0	— 2.8	90	9	65	29	16	43	40	....	....	....	1.57	— 1.2	10	6,938	w.	36	w.	3	12	11	7	4.1	T.
Lincoln	1,189	75	84	28.66	29.93	— .01	49.4	— 1.6	83	8	60	24	14	38	39	42	35	64	2.71	+ 0.1	11	8,238	n.	46	n.	20	7	10	13	6.2	1.2
Omaha	1,105	115	121	28.76	29.95	.00	49.7	— 1.3	80	9	60	24	14	40	33	43	37	67	3.43	+ 0.3	8	7,456	n.	44	n.	13	9	9	12	6.0	1.3
Valentine	2,598	47	54	27.25	29.99	+ .05	42.6	— 4.6	78	7	54	10	14	31	44	36	29	64	2.77	— 0.1	12	7,746	nw.	39	n.	20	8	15	7	5.2	7.3
Sioux City	1,135	96	164	28.74	29.97	+ .02	46.2	— 1.8	78	8	56	20	14	36	38	....	....	....	2.44	— 0.6	12	9,689	n.	54	n.	3	11	5	14	5.9	0.6
Pierre	1,572	43	50	28.32	30.01	+ .06	46.5	+ 0.2	79	7	57	21	17	36	46	39	31	62	1.42	— 0.5	6	5,994	sw.	36	nw.	3	9	5	16	6.0	3.0
Huron	1,306	56	67	28.58	30.00	+ .04	43.8	— 0.6	74	8	56	17	11	31	50	37	29	64	0.67	— 2.3	7	8,151	n.	36	nw.	3	4	11	15	6.5	2.1
Yankton	1,233	55	65	28.64	29.97	+ .02	46.1	— 0.6	77	8	57	19	14	35	44	....	....	....	1.46	— 1.6	11	7,189	nw.	36	ne.	20	3	10	17	7.2	0.5
Northern Slope.							43.3	— 1.3										65	2.33	+ 0.7										5.4	
Havre	2,505	11	44	27.32	29.97	+ .04	44.2	+ 0.2	80	25	59	15	10	30	49	37	29	62	0.70	— 0.3	5	6,717	e.	41	nw.	26	15	13	2	4.0	4.6
Miles City	2,371	42	50	27.45	30.02	+ .06	47.0	+ 0.4	82	26	60	22	13	34	46	40	34	69	0.27	— 0.8	4	5,286	n.	47	nw.	28	11	14	5	4.9	1.3
Helena	4,110	8	56	25.76	29.98	+ .01	43.4	— 0.1	72	24	54	19	14	33	39	35	26	57	0.64	— 0.5	9	4,921	nw.	34	nw.	30	8	11	11	5.8	7.8
Kalispell	2,962	11	34	26.87	29.94	— .02	44.7	....	77	25	57	21	10	32	39	37	28	59	0.73	....	8	4,080	nw.	24	sw.	26	13	13	4	3.9	1.6
Rapid City	3,234	46	50	26.56	30.02	+ .07	42.8	— 3.8	75	7	53	18	16	32	38	37	31	68	1.95	— 0.3	8	4,786	n.	22	nw.	28	8	6	16	6.3	5.7
Cheyenne	6,088	56	64	23.93	29.97	+ .06	37.3	— 3.6	73	30	47	12	20	27	35	33	28	73	6.45	+ 5.1	17	7,129	nw.	38	sw.	27	6	10	14	6.7	46.5
Lander	5,372	26	36	24.56	29.94	.00	42.3	+ 0.3	73	30	56	12	11	29	42	35	28	63	2.55	— 0.2	8	3,216	sw.	26	s.	19	7	14	9	6.1	15.6
Yellowstone Park	6,200	11	47	23.79	29.95	— .01	37.3	....	61	25	50	7	11	25	43	30	22	61	1.52	....	10	5,182	sw.	38	s.	26	6	17	7	5.6	11.9
North Platte	2,821	43	52	27.03	29.98	+ .06	45.8	— 2.8	84	30	57	19	15	34	44	39	33	69	3.78	+ 1.6	12	7,051	n.	42	n.	20	10	9	11	5.5	3.7
Middle Slope.							51.4	— 2.8										67	3.88	+ 1.7										5.8	
Denver	5,291	129	136	24.64	29.92	+ .02	44.6	— 2.3	81	30	56	21	11	34	35	37	29	63	4.95	+ 2.9	11	5,640	n.	43	n.	20	7	12	11	6.4	16.0
Pueblo	4,685	80	86	25.20	29.89	+ .01	47.7	— 2.8	83	30	60	27	5	35	41	39	32	63	3.84	+ 2.4	10	6,245	se.	51	ne.	20	8	13	9	5.7	1.5
Concordia	1,398	42	47	28.46	29.95	+ .02	51.6	— 3.7	89	9	63	24	15	40	43	44	37	65	3.80	+ 1.5	12	5,254	nw.	32	n.	10	8	9	13	6.0	0.6
Dodge	2,509	44	54	27.33	29.93	+ .03	51.0	— 2.7	84	8	64	21	15	38	42	43	37	68	3.84	+ 2.3	11	8,252	se.	49	s.	19	10	9	11	5.7	0.4
Wichita	1,358	78	86	28.51	29.94	+ .01	55.2	— 2.6	90	27	66	33	5	44	37	46	39	63	2.14	— 0.8	6	6,816	s.	36	w.	20	12	12	6	4.9	0.2
Oklahoma	1,214	79	86	28.63	29.90	— .02	58.4	— 2.6	88	27	68	36	5	49	34	54	52	82	4.73	+ 2.1	10	7,991	se.	36	nw.	20	9	10	11	5.9	
Southern Slope.							56.6	— 3.7										65	4.09	+ 1.8										4.6	
Abilene	1,738	45	54	28.08	29.88	— .02	61.2	— 4.1	89	8	72	34	16	50	35	53	48	68	3.66	+ 0.9	11	7,002	sw.	36	se.	1	8	11	11	5.7	
Amarillo	3,676	10	49	26.17	29.89	+ .02	52.0	— 3.3	82	27	63	28	15	41	34	45	39	68	4.52	+ 2.8	10	9,512	se.	42	nw.	20	19	7	4	3.3	0.6
Roswell	3,578	9	57	26.27	29.88	+ .03	56.2	....	84	8	70	31	5	42	45	46	35	58	1.87	....	4	5,360	se.	34	nw.	28	11	10	9	4.9	
Southern Plateau.							56.2	— 2.4										52	1.48	+ 1.0										3.7	
El Paso	3,762	10	110	26.11	29.86	+ .03	59.7	— 4.1	84	17	73	37	1	47	38	46	34	48	1.38	+ 1.2	6	8,943	w.	48	sw.	1	17	7	6	3.3	
Santa Fe	7,013	33	39	23.14	29.84	.00	44.6	— 2.0	68	30	55	22	4	34	33	36	26	55	2.09	+ 1.4	10	5,761	sw.	42	sw.	19	14	10	6	4.1	3.7
Flagstaff	6,907	12	25	23.25	29.82	— .02	42.5	— 4.3	68	29	55	18	13	30	42	35	28	66	2.65	+ 1.0	10	5,376	sw.	36	sw.	19	12	8	10	5.3	9.7
Phoenix	1,108	50	56	28.70	29.85	— .02	64.4	— 2.6	88	30	77	43	2	52	39	54	45	58	2.59	+ 2.3	7	3,441	e.	26	s.	8	14	9	7	4.0	
Yuma	141	16	46	29.70	29.85	— .04	69.2	— 0.9	92	30	81	47	1	57	32	56	45	50	0.16	+ 0.1	1	4,750	s.	29	s.	10	24	6	0	1.5	
Independence	3,910	11	42	25.88	29.83	— .07	56.6	— 0.7	81	29	70	34	12	44	34	43	28	37	T.	— 0.2	0	6,664	se.	44	n.	10	14	10	6	4.2	
Middle Plateau.							49.7	+ 1.2										54	1.10	0.0										5.0	
Carson City	4,720	82	92	25.19	29.89	— .08	48.1	+ 0.1	71	24	61	24	20	35	37	39	31	58	0.89	0.0	5	5,520	sw.	40	sw.	13	12	12	6	4.3	3.0
Winnemucca	4,344	18	56	25.52	29.90	— .06	48.4	+ 1.1	75	25	65	19	12	32	48	38	27	52	0.62	— 0.3	4	5,384	sw.	40	nw.	13	11	7	12	5.3	T.
Modena	5,479	10	43	24.49	29.82	— .06	47.2	+ 2.7	73	29	60	22	1	34	43	38	26	51	1.05	+ 0.3	6	8,203	w.	50	w.	18	15	12	3	3.8	6.5
Salt Lake City	4,366	105	110	25.51	29.86	— .06	51.7	+ 2.2	74	29	62	25	1	42	32	41	29	47	1.70	— 0.5	10	5,101	se.	38	nw.	13	8	11	11	5.5	T.
Durango	6,546	18	56	23.53	29.91	....	44.6	....	71	30	56	24	5	33	37	36	27	59	3.93	....	12	4,305	nw.	32	s.	1	10	5	15	5.9	3.6
Grand Junction	4,608	43	51	25.26	29.82	— .06	53.0	— 0.2	81	30	64	29	4	42	35	44	37	59	1.24	+ 0.5	8	4,051	se.	24	s.	16	9	12	9	5.2	0.8
Northern Plateau.							50.8	+ 1.4										57	1.13	— 0.2										5.6	
Baker City	3,471	78	86	26.39	29.98	— .02	46.8	+ 2.2	72	24	58	28	3	36	35	39	30	57	1.20	0.0	9	4,663	se.	26	nw.	10	6	12	12	6.3	
Boise	2,739	61	68	27.09	29.95	— .03	51.8	+ 0.9	76	5	64	30	11	40	38	43	34	58	0.88	— 0.3	5	4,147	nw.	36	nw.	13	7	14	9	5.9	
Lewiston	757	10	51	29.14	29.96	— .03	54.2	+ 1.2	83	24	66	31	10	43	38	....	....	....	1.51	+ 0.5	6	3,937	e.	46	w.	12	12	7	11	5.0	
Pocatello	4,483	46	54	25.38	29.88	— .06	48.2	+ 1.4	72	6	60	22	1	37	34	39	29	51	1.33	— 0.2	10	6,417	e.	36	sw.	13	11	8	11	5.3	1.0
Spokane	1,929	101	110	27.92	29.97	— .02	49.6	+ 1.6	80	24	61	27	10	38	36	41	32	57	0.91	— 0.4	8	4,437	sw.	26	w.	12	8	6	16	6.2	
Walla Walla	1,000	71	79	28.89	29.97	— .04	54.4	+ 1.1	81	24	65	33	10	44	35	47	39	60	0.97	— 0.6	5	4,274	s.	24	sw.	12	10	18	2	4.7	
N. Pac. Coast Reg.							51.2	+ 2.6										73	1.17	— 3.0										5.2	
North Head	211	11	56	29.80	30.03	— .02	50.4	+ 2.4	71	3	55	40	7	46	27	47	44	82	1.67	— 3.8	12	10,380	nw.	48	se.	16	10	11	9	5.4	
Port Crescent	259	12	29	29.75	30.03	+ .01	46.2	+ 1.6	69	23	55	30	11	38	29	....	....	....	0.53	— 3.5	8	3,989	w.	17	ne.	3	7	11	12	6.1	
Seattle	123	114	151	29.90	30.03	.00	52.7	+ 2.8	85	24	62	37	10	44	33	46	41	70	1.04	— 1.8	10	3,485	nw.	23	sw.	12	10	13	7	5.0	
Tacoma	213	113	120	29.78	30.00	— .03	51.3	+ 2.4	83	24	61	34	3	42	33	....	....	....	0.71	— 2.8	9	4,380	n.	32	sw.	12	10	13	7	5.2	
Tatoosh Island	86	7	57	29.90	30.00	.00	49.2	+ 3.1	61	20	54	39	2	44	16	46	44	84	2.03	— 5.3	12	11,199	e.	52	e.	3	7	6	17	6.7	
Portland, Oreg	153	68	96	29.83	29.99	— .07	55.4	+ 3.8	84	23	66	37	2	45	34	48	40	62	1.71	— 1.6	10	3,837	nw.	27	e.	3	11	8	11	5.1	
Roseburg	518	56	60	29.43	29.99	— .08	53.4	+ 2.2	84	23	66	31	11	41	43	47	40	68	0.52	— 2.1	8	2,494	nw.	20	n.	10	19	8	3	3.2	
Mid. Pac. Coast Reg.							57.2	+ 1.7										71	1.00	— 1.7										4.1	
Eureka	62	62	80	29.95	30.02	— .09	52.6	+ 2.6	66	11	58	42	10	48	21	49	46	79	0.78	— 3.5	9	5,973	n.	36	n.	26	9	13	8	5.0	
Mount Tamalpais	2,375	11	18	27.49	29.96	— .09	52.2	....	68	27	58	39	30	46	19	46	41	71	1.14	....	6	11,542	nw.	60	nw.	30	11	7	12	5.1	
Red Bluff	332	50	56	29.57	29.93	— .10	60.8	+ 1.5	87	23	73	39	19	49	34	51	43	60	0.70	— 1.5	3	3,957	n.	27	n.	9	18	7	5	3.5	
Sacramento	69	106	117	29.85	29.92	— .09	59.2	+ 1.0	81	28	69	43	20	49	30	52	47	70	1.18	— 1.1	4	5,816	s.	30	nw.	10	16	10	4	3.3	
San Francisco	155	161	167	29.82	30.00	— .05	56.4	+ 1.8	71	11	62	49	18	51	17	51	48	76	1.33	— 0.6	6	7,575	w.	32	w.	30	14	12	4	3.7	
S. Pac. Coast Reg.							59.4	+ 0.7										73	0.47	— 0.9										5.4	
Fresno	330	67	70	29.56	29.92	— .07	62.3	+ 1.5	86	28	75	38	1	49	34	51	42	56	0.45	— 0.9	3	4,023	nw.	21	n.	15	16	10	4	3.5	
Los Angeles	338	116	123	29.58	29.95	— .04	59.5	+ 0.6	74	5	68	42	1	51	26	53	50	78	0.35	— 1.0	4	3,581	w.	25	sw.	19	8	5	17	6.2	
San Diego	87	94	102	29.83	29.92	— .07	59.1	+ 0.8	68	18	64	44	1	54	18	54	51	78	0.30	— 0.5	6	4,321	nw.	23	s.	23	10	11	9	5.5	
San Luis Obispo	201	47	54	29.76	29.98	— .07	56.6	— 0.2	76	28	65	41	13	48	28	52	49	80	0.77	— 1.2	3	3,561	nw.	24	w.	16	7	8	15	6.2	
West Indies.																															
Grand Turk	11	6	20	29.97	29.98	— .03	78.8	....	88	29	84	66	4	74	18				0.93		6		e.								
Havana	57	87	105	29.90	29.96	— .03	74.6	— 1.5	89	30	81	61	9	68	21				4.70	+ 1.9	9	8,775	e.	51	e.	20	13	6	11	5.0	
San Juan	82	48	90	29.89	29.98	.00	78.3	+ 1.0	90	14	84	69	3	73	17	72	69	75	2.29	— 1.3	14	8,685	e.	31	se.	13	9	15	6	4.9	

* More than one date.

TABLE II.—*Climatological record of cooperative observers, April, 1905.*

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
	°	°	°	*Ins.*	*Ins.*
Alabama.					
Alaga				1.56	
Anniston	87	26	59.3	2.73	
Ashville	86	27	60.4	3.48	
Benton				1.19	
Bermuda	91	36	66.8	1.98	
Boligee	87	32	65.0	5.46	
Burkeville				1.05	
Calera				4.05	
Camp Hill	88	29	63.4	3.16	
Cedar Bluff				3.49	T.
Citronelle	86	38	67.5	4.92	
Clanton	85	33	62.7	3.89	
Cordova	86	28	63.6	5.40	
Dadeville				2.72	
Daphne	85	43	67.7	3.57	
Decatur	87	32	63.4	3.41	
Delmar	86	30	62.4	4.34	
Eufaula	86	36	64.6	3.28	
Evergreen	89	38	66.4	2.54	
Flomaton	92	36	69.0	3.30	
Florence	87	27	61.6	3.52	
Fort Deposit	87	38	63.1	3.14	
Gadsden	89	28	62.6	3.88	
Goodwater	86	39	64.8	4.41	
Greensboro	85	35	64.8	4.21	
Greenville				1.55	
Hamilton	86	27	62.7	5.49	
Highland Home	88	36	65.4	2.15	
Letohatchie				2.83	
Livingston	85	30	63.1	5.25	
Lock No. 4	88	29	63.4	3.21	
Lucy	92	35	66.3		
Madison Station	88	30	62.3	3.79	
Maplegrove	88	28	59.8	4.71	T.
Marion	86	34	64.7	2.75	
Newbern	87	32	64.2	3.15	
Notasulga				6.72	
Oneonta	87	26	61.9	4.06	T.
Opelika	87	40	65.1	4.39	
Ozark	90	38	66.0	3.59	
Prattville	86	31	64.2	2.58	
Pushmataha	89	31	66.3	5.19	
Riverton	87	26	62.2	3.90	
Scottsboro	86	26	60.8	4.44	T.
Selma	87	36	65.8	1.28	
Spring Hill		46		6.03	
Talladega	86	30	59.8	4.86	
Tallassee				2.58	
Thomasville	89	31	64.2	3.19	
Tuscaloosa	86	32	62.4	5.52	
Tuscumbia	88	31	61.8	3.96	
Tuskegee	87	35	65.8	4.01	
Union Springs	85	34	65.4	2.87	
Uniontown	86	29	62.9	2.74	
Valleyhead	90	25	60.3	4.35	T.
Wetumpka	88	32	65.8	2.52	
Alaska.					
Chestochena	55	10	31.9	0.00	
Fort Liscum	50	20	35.9	2.96	7.2
Killisnoo	61	24	41.2	2.20	
Orca	70			9.10	1.0
Sitka	57	25	42.1	7.52	
Teikhill	51	1	30.6	0.04	T.
Wood Island	58	23	41.2	1.70	
Arizona.					
Allaire Ranch				1.12	T.
Alpine				3.20	9.5
Aztec	97	49	70.7	T.	
Benson	85	34	59.7	2.01	
Bisbee	78	29	53.2	4.04	6.0
Blue	79	23	49.9	2.88	5.5
Bowie	88	35	61.1	1.19	
Buckeye	93	41	64.0	2.04	
Casagrande	93	40	66.9	1.27	
Cochise *[1]	76	34	53.2	1.12	
Congress	80	41	60.0	3.96	
Douglas	85	32	58.3	1.91	T.
Dudleyville	87	33	60.8	3.90	
Duncan	83	28	55.0	1.74	1.5
Fort Apache	73	24	48.4	5.00	10.0
Fort Defiance	68	12	42.2	2.61	
Fort Grant	83	29	57.1	1.21	9.0
Fort Huachuca	80	30	56.7	1.94	
Fort Mohave	95	35	68.7	0.54	
Gilabend	95	40	66.4	T.	
Globe	83	38	58.8	2.86	
Greaterville	77	29	52.0	2.43	4.0
Greer				3.70	26.6
Holbrook	79	28	52.0	1.57	
Jerome	77	35	54.8	3.70	
Kingman	80	34	57.4	2.42	
Maricopa	98	40	65.1	1.71	
Mesa	91	40	64.0	2.70	
Mohawk Summit *[1]	90	55	70.0	0.13	
Natural Bridge				4.34	T.
Nutrioso				4.94	18.2
Oracle				2.42	4.0
Oro				2.35	0.7
Arizona—Cont'd.					
Paradise				1.84	0.5
Parker	98	45	70.0	0.12	
Phoenix	90	39	63.2	2.59	
Picacho *[1]	89	50	66.5	1.60	
Pinal Ranch				5.48	
Pinto				2.08	T.
Prescott	76	26	49.9	3.81	1.0
Providence				3.73	T.
San Carlos	87	32	59.8	3.34	
San Simon	83	30	57.4	0.21	
Seligman	77	25	49.4	1.65	T.
Sentinel *[1]	95	48	69.6	0.20	
Showlow				6.26	24.5
Superstition				3.72	
Taylor	76	30	50.4	1.05	
Tempe	91	34	63.6	2.20	
Thatcher	88	30	59.6	0.93	
Tombstone	78	34	56.7	1.41	
Tuba				2.58	11.0
Tucson	79	36	58.4	3.53	
Upper San Pedro	84	30	56.2	1.12	
Vail *[6]	78	47	64.4	2.91	
Walnut Grove				2.27	
Wilcox	80	32	55.5	1.41	T.
Williams	72	22	44.8	3.08	15.0
Yarnell				5.15	
Young	82	25	55.2	4.59	
Arkansas.					
Amity	87	37	62.2	7.21	
Arkadelphia	85	37	62.7	7.75	
Arkansas City				8.48	
Batesville	86	35	61.4	6.27	
Beebranch	86	34	59.0	3.20	
Black Rock				8.80	
Blanchard	87	34	63.4	8.42	
Brinkley	90	36	62.0	8.55	
Calico Rock				2.59	
Camden	86	42	64.2	10.07	
Clarendon				7.89	
Conway	90	35	62.9	4.54	
Dallas	86	37	62.0	8.77	
Dardanelle				4.38	
Des Arc	85	36	63.0	9.15	
Dodd City	92	28	58.1	2.10	
Dutton	86	29	56.6	5.01	T.
Eldorado	90	38	63.6	8.20	
Elon	89	36	65.0		
Eureka Springs	89	33	59.2	3.70	
Fayetteville	88	33	56.9	4.42	
Forrest City	86	36	60.6	7.28	
Fulton				4.58	
Hardy	88	31	59.6	4.66	T.
Heber		31[j]	60.4[j]	5.11	
Helena [b]	85	36	62.3	7.25	
Hope	86	39	64.0	6.29	
Howe	96	38	63.5	9.47	
Jonesboro	89	30	66.0		
Lacrosse	91	32	57.2	2.49	T.
Lake Village	89	35	63.6	7.27	
Lonoke	90	35	63.0	8.36	
Lutherville	90	33	59.2	4.33	T.
Luxora				3.65	
Malvern	87	37	60.8	8.25	
Marked Tree				7.84	
Marvell	86	36	62.6	9.07	
Mossville	86	33	55.6	4.45	T.
Mount Nebo	83	34	57.9	4.49	T.
New Gascony	84	39	62.0		
New Lewisville	87	39	63.1	7.41	
Newport	89	34	62.0	8.56	
Oregon	91	28	57.4	2.21	T.
Osceola	91	30	59.9	3.80	
Ozark	91	38	60.8	4.51	T.
Perry	90	37	61.9		
Pinebluff	86	38	62.8	12.53	
Pocahontas	86	34	60.6	7.40	
Pond	89	25	57.7	4.65	
Prescott	87	40	62.8	6.62	
Princeton	86	35	63.0	11.00	
Russellville	87	32	57.9	4.52	
Silversprings	86	32	57.4	2.95	T.
Spielerville	91	38	61.6	4.27	T.
Springbank				7.90	
Stuttgart	85	37	62.0	7.65	
Tate	93	33	61.3	4.26	
Texarkana	86	35	62.2	4.46	
Warren	88	37	63.2	10.79	
White Cliffs				6.27	
Wiggs	87	33	61.0	6.05	
Winchester	85	39	64.6	9.27	
Witts Springs	79	32	54.4	3.95	T.
California.					
Alturas				0.51	
Angiola	90	30	61.0	0.03	
Auburn	82	39	58.6	1.92	
Azusa	82	35	59.1	1.49	
Bagdad	91	58	77.2	0.00	
Bakersfield	99	35	63.6	T.	
California—Cont'd.					
Barber				1.35	
Barstow	92	48	66.8	0.40	
Bear Valley				3.17	12.0
Bishop	83	27	53.4	0.04	
Blue Canyon	68	25	45.8	2.70	9.0
Bodie	63	6	36.0	1.23	9.0
Bowman				4.88	21.0
Branscomb	74	33	50.6	2.75	
Brush Creek	84	30	55.0	2.46	
Butte Valley				2.48	0.5
Calabasas				0.64	
Calexico	91	46	68.3	0.50	
Cambria				0.88	
Campbell	77	36	55.2	1.09	
Campo				0.92	
Cedarville	73	26	47.7	0.25	
Chico	84	40	60.9	1.57	
Claremont	87	39	58.6	0.94	
Cloverdale	85	36	58.2	1.63	
Colfax	78	35	55.2	3.01	
Colusa	81	43	60.0	0.76	
Craftonville				1.34	
Crescent City	69	37	52.6	1.67	
Crockers				2.70	
Cuyamaca	65	28	43.7	3.64	
Delta	84	34	56.0	7.53	
Diamond				1.63	
Dobbins	88	38	60.4	2.59	
Drytown	80	35	58.6	1.70	
Durham	86	36	59.1	1.37	
Elcajon	80	34	59.2	0.36	
Electra	83	42	61.2	2.17	
Elmwood	86[c]	36[d]	62.2[e]	0.55	
Elsinore	82	36	59.8	0.30	
Emigrant Gap	66	24	42.7	1.60	10.0
Escondido	88	30	62.9	0.45	
Folsom	83	40	60.2	1.60	
Fordyce				3.23	21.0
Fort Bragg				0.67	
Fort Ross	70	39	53.3	2.33	
Foster				0.86	
Fruitvale				1.47	
Georgetown	75	32	53.2	2.80	
Gilroy (near)	80	36	58.3	0.89	
Glens Ranch				0.60	
Greenville	75	24	49.0	1.34	
Hanford	90	36	63.6	0.56	
Healdsburg	86	30	59.0	2.12	
Hollister	78	36	56.0	0.94	
Indio	93	45	70.4	0.00	
Idylwild	69	23	46.8	2.21	T.
Imperial	96	43	68.4	0.15	
Iowa Hill	75	35	54.1	2.58	
Irvine				0.50	
Isabella	82	32	58.5	0.36	
Jolon				0.53	
Kennedy Gold Mine				2.93	
Kentfield				1.61	
Kernville				0.52	
King City	80	33	57.0	0.42	
Laytonville				2.15	
Le Grand	88	36	59.1	0.62	
Lemoncove	90	39	63.5	0.75	
Lick Observatory	65	32	47.2	1.36	
Livermore	84	36	57.2	0.93	
Lodi	82	38	59.0	0.80	
Lone Pine	81	29	55.6	0.16	
Los Gatos	78	41	56.4	1.21	
Lowe Observatory				1.07	
Magalia	84	39	60.8	1.84	
Mammoth	96	41	69.8	0.00	
Marysville	84	41	60.4	1.20	
Meadow Valley				1.29	2.0
Merced	87	35	61.4	0.25	
Mercury				2.21	
Mills College				1.60	
Milo				0.79	
Milton (near)	78	42	59.6	1.65	
Mokelumne Hill				2.08	
Montague	83	28	52.9	0.36	
Monterio	74	30	52.6	1.75	
Monumental	78	29	48.9	2.56	
Mount St. Helena				2.64	
Napa	77	38	56.4	0.94	
Needles	94	50	72.0	0.50	
Nellie				2.43	0.8
Nevada City	80	30	52.1	2.88	
Newcastle	82	41	62.0	2.38	
Newman	88	40	62.4	0.55	
Niles	78	42	58.2	1.40	
Nordhoff	77	28	50.4	0.61	
North Bloomfield	75	29	51.6	2.82	
Oakland	74	47	58.6	1.34	
Ontario (near)	86	35	60.2	0.82	
Orland	88	37	62.9	0.65	
Orleans	94	34	62.6	1.55	
Oroville (near)	84	42	61.0	1.97	
Palermo	88	39	59.4	2.03	

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
California—Cont'd.	°	°	°	*Ins.*	*Ins.*
Peachland	78	37	55.8	1.94	
Pilot Creek	.....	.....	.....	3.17	12.0
Pine Crest	73	44	56.0	0.79	
Placerville	74	32	53.2	2.61	
Point Lobos	68	51	59.0	1.54	
Point Loma	.....	.....	.....	0.55	
Point Keyes Light	65	48	53.2	1.15	
Poway	75	34	60.4	0.42	
Priest Valley	.....	.....	.....	0.71	
Quincy	73	28	49.9	1.52	
Redding	82	41	60.4	0.83	
Reedley	94	33	62.6	0.74	
Repress	.....	.....	.....	1.96	
Riovista	80	40	59.4	1.03	
Riverside	96	36	59.3	0.45	
Rocklin	82	39	59.7	1.88	
Rohnerville	.....	.....	.....	0.82	
Sacramento	80	43	59.7	1.38	
Salinas	73	36	56.6	1.08	
Salton	93	48	69.9	0.00	
San Bernardino	89	36	60.0	1.18	
San Jacinto	74	30	54.3	1.03	
San Jose	80	41	58.5	1.01	
San Leandro	74	39	57.3	1.63	
San Rafael	76	40	57.4	1.18	
Santa Barbara	75	44	58.2	0.51	
Santa Clara College	80	36	56.8	1.10	
Santa Cruz	77	36	55.8	2.30	
Santa Maria	75	39	57.6	0.69	
Santa Monica	83	44	62.0	.....	
Santa Rosa	78	34	55.2	1.45	
Sausalito	.....	.....	.....	1.56	
Shasta	88	37	62.2	3.25	
Sierra Madre	79	40	58.0	2.14	
Sisquoc Ranch	.....	.....	.....	0.75	
Sisson	80	28	51.0	2.01	
Snedden	.....	.....	.....	0.40	
Sonoma	.....	.....	.....	1.06	
Sonora	75	42	59.4	2.30	
Sterling	.....	.....	.....	1.75	T.
Stockton	80	41	55.8	0.72	
Storey	84	35	58.8	0.72	
Summerdale	65	28	46.2	2.56	4.0
Summit	60	28	41.9	2.90	23.0
Susanville	76	26	48.4	0.09	
Tejon	82	44	61.2	1.02	
Towle	72	31	47.2	6.11	
Truckee	64	10	43.7	1.65	6.0
Tulare	88	36	61.7	0.63	
Tustin	.....	.....	.....	0.41	
Ukiah	83	33	56.6	1.37	
Upland	80	36	55.6	0.88	
Upperlake	81	32	54.2	1.11	
Upper Mattole	.....	.....	.....	3.34	
Vacaville	83	40	58.4	0.84	
Ventura	76	46	60.2	0.29	
Visalia	93	30	59.6	0.38	
Volcano	90	48	70.9	0.00	
Wasco	88	38	62.2	0.00	
Wasioja	.....	.....	.....	1.41	
Weldon	.....	.....	.....	0.35	
Westpoint	.....	.....	.....	2.18	
Wheatland	79	40	58.6	1.63	
Willow	85	50	66.6	0.50	
Woodside	74	40	56.1	1.87	
Yosemite	77	27	51.4	2.61	1.0
Yreka	.....	.....	.....	0.39	
Zenia	73	30	48.6	2.45	
Colorado.					
Akron	.....	.....	.....	4.55	4.5
Alford	69	10	38.4	5.26	32.0
Antelope Springs	55	-2	31.2	2.02	20.1
Ashcroft	64	1	33.0	1.18	11.0
Blaine	78	24	49.3	4.31	
Boulder	77	21	46.4	6.65	21.5
Breckenridge	59	-4	32.3	2.30	31.0
Burlington	81	19	45.6	4.82	.....
Canyon	83	22	48.0	5.43	12.0
Cheesman	70	9	41.3	3.59	12.0
Cheyenne Wells	85	18	47.2	5.16	T.
Clearview	60	-5	32.5	3.84	38.0
Collbran	77	20	46.7	1.61	6.0
Colorado Springs	73	21	42.4	4.46	8.0
Conejos [1]	65	16	39.5		
Cripplecreek	.....	.....	.....	1.76	16.7
Eagle	73	15	43.2	1.55	3.0
Fort Collins	78	12	43.4	6.32	15.0
Fowler	.....	.....	.....	4.51	T.
Fox	83	16	46.1	4.08	T.
Frances	72	10	37.9	6.43	46.0
Fruita	82	25	51.0	1.24	.....
Garnett	70	17	41.6	0.46	.....
Gleneyre	78	15	41.7	5.51	14.0
Glenwood Springs	76	19	45.8	1.06	.....
Grand Valley	79	23	49.0	1.21	1.0
Greeley	82	21	46.0	4.08	5.0
Gunnison	72	11	39.8	0.50	2.0
Halls Gulch	.....	.....	.....	1.94	16.8
Colorado—Cont'd.					
Hamps	75	16	43.0	4.86	9.0
Hoehne	79	15	44.4	5.00	9.5
Holly	82	18	49.6	3.43	
Holyoke (near)	80	15	44.6	5.67	9.0
Idaho Springs	68	6	40.2	3.95	29.2
Lake Moraine	52	5	30.7	8.70	96.0
Lamar	85	26	52.4	5.86	
Laporte	.....	.....	.....	5.51	10.8
Las Animas	88	24	50.8	5.24	T.
Lay	74	17	41.2	1.64	9.0
Leroy	80	17	43.1	4.70	10.4
Longs Peak	61	-4	31.3	5.01	62.0
Mancos	72	18	43.8	4.71	.....
Marshall Pass	.....	.....	.....	1.93	31.0
Meeker	68	17	42.4	2.04	5.3
Montrose	73	29	45.2		.....
Moraine	65	4	36.4	7.10	85.0
Pagoda	73	19	42.4	2.23	.....
Paonia	79	20	49.4	0.77	
Platte Canyon	.....	.....	.....	4.87	12.0
Rockyford	84	19	49.2	4.67	
Saguache	74	10	40.0	0.40	2.0
Salida	73	12	41.6	4.06	13.0
San Luis	64	15	40.8	2.02	3.0
Santa Clara	69	10	39.2	7.41	56.0
Sheridan Lake	84	18	48.6	5.96	T.
Silt	75	18	46.4	1.14	4.5
Silverton	58	3	33.0	2.95	9.5
Sugar City	.....	.....	.....	6.04	
Sugar Loaf	69	11	36.2	7.11	76.0
Trinidad	75	24	45.8	4.82	.....
Victor	64	6	34.0	3.30	26.0
Vilas	.....	.....	.....	5.94	
Wagon Wheel	63	3	34.9	.....	11.0
Walden	64	6	34.8	1.09	15.4
Waterdale	76	20	42.4	5.59	.....
Westcliffe	70	5	38.8	2.72	2.5
Whitepine	57	-6	31.0	2.11	25.0
Wray	86	18	47.8	5.12	T.
Yuma	.....	.....	.....	4.27	8.0
Connecticut.					
Bridgeport	72	27	48.0	3.40	T.
Canton	77	19	45.2	2.38	T.
Colchester	73	25	47.0	3.89	T.
Falls Village	.....	.....	.....	2.50	1.5
Hawleyville	76	24	47.1	3.14	0.5
Lake Konomoc	.....	.....	.....	3.35	.....
New London	67	29	47.3	3.39	T.
North Grosvenor Dale	74	22	46.0	2.88	T.
Norwalk	73	23	47.0	3.14	
Southington	73	22	47.0	2.12	0.2
South Manchester	.....	.....	.....	3.38	0.5
Storrs [f]	72	24	44.8	.....	.....
Voluntown	73	24	46.7	3.38	.....
Wallingford	.....	.....	.....	2.95	.....
Waterbury	77	25	48.1	2.85	T.
West Cornwall	75	24	44.6	2.74	2.3
West Simsbury	.....	.....	.....	2.16	T.
Delaware.					
Delaware City	.....	.....	.....	3.37	T.
Milford	85	27	54.1	2.97	
Millsboro	85	26	53.0	2.66	
Newark	79	26	51.4	3.48	T.
Seaford	81	27	62.2	2.89	
District of Columbia.					
Distributing Reservoir*[b]	80	38	56.0	2.11	.....
Receiving Reservoir*[b]	80	34	54.7	2.38	.....
West Washington	86	26	53.4	3.09	0.2
Florida.					
Apalachicola	85	46	69.4	1.65	
Archer	90	39	70.2	1.32	
Avon Park	95	50	72.0	3.01	
Bartow	94	45	71.6	3.20	
Bonifay	89	42	68.6	4.28	
Brooksville	90	40	70.6	2.22	
Carrabelle	85	42	68.6	1.12	
Clermont	94	47	72.8	2.10	
De Funiak Springs	91	39	67.6	2.44	
Deland	92	38	70.8	.....	
Eustis	91	43	70.4	2.45	
Federal Point	88	40	68.8	1.16	
Fernandina	89	44	68.8	2.03	
Flamingo	85	49	73.5	1.08	
Fort Meade	96	45	71.0	2.71	
Fort Pierce	91	49	72.3	4.95	
Grasmere	91	45	70.8		
Huntington	93	42	70.0	1.62	
Hypoluxo	91	54	72.7	4.06	
Inverness	87	42	69.1	2.21	
Jasper	88	39	67.8	2.29	
Kissimmee	93	45	70.6	1.82	
Macclenny	90	38	68.6	3.60	
Madison	89	42	69.0	1.69	
Malabar	95	50	73.3	3.95	
Manatee	90	46	70.4	3.14	
Marco	91	56	73.4	9.86	
Merritt Island	90	53	72.5	4.75	
Miami	90	52	74.9	1.32	
Florida—Cont'd.					
Middleburg	92	32	67.3	4.51	
Milton	85	52	69.2	1.12	
Molino	91	35	66.8	3.97	
Monticello	91	38	69.2	0.90	
Mount Pleasant	91	40	69.2	1.74	
Myers	93	50	72.2	4.83	
Nocatee	93	44	71.4	3.60	
Ocala	91	40	70.2	1.94	
Orange City	96	38	71.0	1.56	
Orange Home	90	42	69.8	2.05	
Orlando	93	45	71.0	1.71	
Pinemount	88	38	67.9	1.87	
Plant City	95	42	70.8	2.13	
Rockwell	89[e]	41[e]	69.7[e]	1.98	
St. Andrews	86	36	68.2	1.66	
St. Augustine	93	40	69.0	1.33	
St. Leo	91	43	70.3	3.01	
Sand Key	88	61	74.2	4.50	
Stephensville	98	35	66.8	0.82	
Sumner	88	34	68.6	1.30	
Switzerland	90	41	68.6	2.44	
Tallahassee	90	41	69.0	0.92	
Tarpon Springs	86	41	69.2	2.75	
Titusville	93	43	70.2	2.71	
Wausau	.....	40	.....	2.03	
Wewahitchka	88	44	69.0	1.46	
Georgia.					
Abbeville	.....	.....	.....	3.92	
Adairsville	86[c]	32[c]	61.1[c]	2.89	T.
Albany	88	38	68.1	5.35	
Allapaha	88	39	67.4	2.56	
Americus	85	34	64.4	4.93	
Athens	86	31	61.0	3.25	
Bainbridge	92	39	70.0	2.08	
Blakely	92	37	66.9	2.20	
Bowersville	.....	.....	.....	2.00	
Butler	.....	.....	.....	4.95	
Camak	89	32	63.6	5.35	T.
Cariton	.....	.....	.....	2.91	
Carrollton	88[c]	29[c]	61.2[c]	2.18	
Canton	.....	.....	.....	3.18	
Clayton	83	26	57.3	3.81	T.
Columbus	87[d]	35[d]	66.0[d]	5.48	
Cordele	86	34	67.0	5.91	
Covington	90	30	63.2	3.62	T.
Cuthbert	80	34	64.9	5.36	
Dahlonega	85	29	59.6	3.06	T.
Dawson	87	33	66.4	6.31	
Diamond	84	27	58.2	4.84	T.
Dublin	.....	.....	.....	5.28	
Dudley	89	33	65.6	3.29	
Eastman	88	36	67.0	4.77	
Eatonton	89[c]	31[c]	63.1[c]	4.15	
Elberton	87	31	63.0	3.52	
Experiment	88	32	63.1	2.61	T.
Fleming	94	35	67.4	1.06	
Forsyth	89	30	63.6	2.87	
Fort Gaines	87	37	66.2	4.54	
Gainesville	85	32	60.8	2.52	T.
Gillsville	86	30	60.9	2.95	
Glenville	91	37	66.3	1.63	
Greenbush	88	30	60.4	4.20	T.
Greensboro	89	30	63.2	2.18	
Griffin	89	.....	.....	3.01	
Harrison	88	28	63.8	4.45	
Hawkinsville	89	33	65.1	2.34	
Lost Mountain	88	31	61.6	2.48	T.
Louisville	87	33	64.6	4.94	
Lumpkin	86	32	64.8	5.14	
Marshallville	89	33	66.0	3.74	
Mauzy	91	38	69.4	1.82	
Milledgeville	88	34	63.9	2.98	
Millen	88	34	64.8	5.02	
Montezuma	.....	.....	.....	2.71	
Monticello	91	32	63.9	2.80	
Morgan	89	36	65.9	3.13	
Newnan	90	29	61.8	3.90	
Point Peter	89[e]	30[e]	62.5[e]	2.76	
Poulan	87	33	66.1	5.01	
Putnam	87	33	65.4	5.10	
Quitman	96	40	68.8	1.68	
Ramsey	84	27	62.5	4.17	
Resaca	.....	.....	.....	3.52	
Rome	90	28	61.2	3.72	T.
St. Marys	91	37	68.5	2.22	
Statesboro	91	35	67.0	3.11	
Swainsboro	92	.....	.....	3.69	
Talbotton	90	30	63.4	4.34	
Tallapoosa	89	30	62.5	4.04	
Thomasville	91	38	68.9	0.82	
Toccoa	85	27	60.3	1.32	
Valdosta	91	39	68.8	3.80	
Valona	90	37	66.3	1.01	
Vidalia	83	36	65.9	4.10	
Washington	86	32	63.0	3.69	
Waverly	90	36	67.6	3.34	
Waycross	91	37	68.7	1.96	
Waynesboro	86	32	64.7	4.67	

Table II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
	°	°	°	Ins.	Ins.
Georgia—Cont'd.					
Westpoint	91	32	.....	3.97	
Woodbury	83	29	62.6	2.30	
Idaho.					
Albion	74	19	47.6	1.40	T.
American Falls	75	21	48.4	1.01	
Blackfoot	75	19	47.6	0.38	
Blue Lakes	81	27	54.6	1.00	
Burnside	65	14	37.8	0.57	1.0
Caldwell	80	28	52.4	0.75	
Cambridge	79	26	51.3	0.58	
Chesterfield	69	16	43.4	1.41	T.
Dewey	68	14	42.1	1.59	.....
Ellerslie	77	27	50.0	0.78	0.2
Fernwood	82	21	48.6	1.91	.....
Forney	75	14	43.1	1.88	.....
Franklin	.....	.....	.....	3.21	.....
Garnet	83	29	56.0	0.27	.....
Glens Ferry[a]	82	21	53.2	.....	.....
Grangeville	72	24	47.0	4.53	T.
Hope	.....	.....	.....	0.88	.....
Idaho City	69	14	45.9	1.17	.....
Idaho Falls	73	17	47.0	0.84	.....
Kellogg	79	20	46.4	1.23	.....
Ketchum	.....	.....	.....	0.15	.....
Lake	60	10	33.6	1.20	7.0
Lakeview	76	26	47.4	0.90	2.0
Landore	64	15	40.2	2.55	1.6
Lemhi Agency	74	15	43.2	1.05	2.8
Lost River	69	8	44.3	1.08	1.0
Lovell	83	24	49.8	1.96	.....
Malad	75	21	45.4	.....	.....
Meadows	76	23	46.4	1.75	.....
Minidoka	74[f]	23[f]	50.6[f]	0.57	.....
Mink Creek	.....	.....	.....	0.77	.....
Moscow	78	24	49.0	1.91	.....
Murray	76	16	44.8	0.85	T.
Oakley	75	26	49.6	0.91	.....
Ola	73	28	49.8	1.06	.....
Orofino	88	26	52.8	1.74	.....
Paris	65	15	41.4	2.15	5.0
Payette	80	28	53.0	0.32	.....
Pearl	.....	.....	.....	1.19	.....
Pollock	78	30	52.8	2.07	
Poplar	.....	.....	.....	0.22	.....
Porthill	76	21	47.2	0.50	3.0
Priest River	77	19	48.6	0.48	.....
Roosevelt	55	8	34.6	1.45	9.9
St. Maries	81	20	48.8	1.50	.....
Salem	.....	.....	.....	1.67	0.5
Soldier	70	13	40.9	0.89	.....
Swan Valley	69	14	40.1	.....	.....
Vernon	70	18	44.0	0.25	.....
Victor	65	15	40.0	0.95	6.5
Westlake	.....	.....	.....	4.05	.....
Weston	72	20	47.4	2.20	1.0
Illinois.					
Albion	84	28	55.8	4.21	T.
Alexander	88	27	53.2	1.82	0.5
Ashton	79	26	47.5	3.95	1.0
Astoria	83	28	51.0	3.53	0.5
Aurora	80	25	47.8	3.85	T.
Beardstown	.....	.....	.....	3.38	.....
Benton	87	30	59.0	1.65	
Bloomington	86	27	52.6	5.11	0.5
Bushnell	86	27	52.1	4.12	1.0
Cambridge	84	27	50.1	3.83	1.5
Carlinville	88	28	54.4	3.68	1.0
Carrollton	87	28	53.9	2.51	.....
Charleston	84	29	53.4	3.00	
Chester	92	32	60.8	4.20	
Cisne	85[d]	29[d]	55.2[d]	.....	0.5
Coatsburg	85	25	52.0	2.42	T.
Cobden	87	29	58.0	4.83	T.
Colchester	85	20	52.0	3.36	1.0
Decatur	85	28	51.8	3.11	T.
Dixon	81	28	48.8	3.66	T.
Effingham	84	29	53.9	3.62	0.5
Equality	88	32	57.5	3.38	T.
Flora	83	29	54.6	3.45	1.0
Friendgrove	81	29	55.1	4.18	0.1
Galva	82	26	49.0	4.78	2.0
Grafton	.....	.....	.....	2.94	.....
Greenville	87	29	55.2	3.91	0.5
Griggsville	88	28	53.8	2.85	T.
Halfway	83	32	57.2	3.59	T.
Havana	86	27	53.1	3.91	.....
Henry	83	28	51.4	3.87	T.
Hillsboro	88	29	53.6	3.21	0.2
Hoopeston	80	26	51.1	3.91	1.5
Joliet	83	28	49.8	4.13	0.6
Kishwaukee	80	28	47.8	2.90	T.
Knoxville	81	20	47.0	5.38	2.0
Lagrange	80	25	47.4	3.41	T.
Laharpe	84	26	51.2	4.47	2.0
Lanark	78	23	47.8	2.41	0.3
Loami	.....	.....	.....	1.97	T.
McLeansboro	84	31	53.2	4.25	T.
Martinsville	82	28	52.2	4.01	T.
Illinois—Cont'd.					
Martinton	82	28	49.7	3.96	T.
Mascoutah	84	30	53.2	5.69	
Mattoon	80	31	56.6	2.08	T.
Minonk	83	26	50.8	3.88	2.0
Monmouth	84	27	51.3	4.98	2.0
Morrison	78	26	49.3	3.80	0.5
Morrisonville	85	27	53.1	3.87	1.0
Mount Carmel	.....	.....	.....	4.82	1.0
Mount Pulaski	85	27	52.5	3.99	T.
Mount Vernon	85	30	55.4	4.92	0.5
New Burnside	87	29	57.6	5.25	T.
Olney	84	30	53.9	3.74	0.4
Ottawa	85	28	51.2	5.15	T.
Palestine	83	30	54.8	3.36	T.
Pana	83	27	53.5	2.31	1.5
Paris	80	29	52.4	3.75	
Peoria *a*	.....	.....	.....	3.99	.....
Philo	87	27	51.2	3.79	T.
Plumhill	85	30	55.5	4.34	
Pontiac	84	28	51.3	3.45	1.0
Princeville	80	26	50.2	3.49	
Rantoul	85	26	50.2	3.70	T.
Raum	87	28	57.0	4.12	T.
Riley	78	27	46.6	3.31	0.5
Robinson	82	30	55.5	3.86	T.
Rockford	.....	.....	.....	2.70	T.
Rushville	86	26	53.6	3.53	T.
St. Charles	80	24	47.2	3.59	T.
St. John	86	28	57.6	4.25	T.
Shobonier	85	28	55.4	4.57	1.0
Streator	81	27	49.0	1.22	T.
Sullivan	85	26	52.6	2.28	
Sycamore	83	27	47.3	3.14	0.4
Tilden	85	30	56.4	4.63	T.
Tiskilwa	78	26	49.0	4.59	0.5
Tuscola	84	27	51.0	3.62	.....
Urbana	83	26	50.6	2.95	0.4
Walnut	83	27	50.8	3.88	T.
Warsaw	.....	.....	.....	2.96	T.
Winchester	87	28	52.9	2.02	T.
Windsor	83	26	52.5	2.22	T.
Winnebago	80	27	47.4	3.59	3.5
Yorkville	80	27	48.0	4.04	
Zion	78	26	48.2	2.18	5.0
Indiana.					
Anderson	79	25	51 2	5.22	0.5
Angola	76	22	47.2	3.67	8.2
Auburn	78	20	46.6	3.64	.....
Bedford	.....	30	.....	3.50	T.
Bloomington	81	[illegible]	53.4	4.81	.....
Bluffton	81	24	50.0	3.08	2.0
Butlerville	82	26	53.9	3.32	T.
Cambridge City	79	23	49.4	3.77	1.2
Columbus	82	26	53.2	3.91	T.
Connersville	82	24	50.6	4.98	T.
Crawfordsville[h]	81	27	50.4	.....	.....
Delphi	82	25	49.3	4.22	2.5
Farmersburg	81	30	53.2	3.96	T.
Farmland	77	24	49.7	4.58	0.5
Fort Wayne	83	22	49.1	3.61	1.8
Franklin	81	27	53.0	4.19	.....
Greencastle	77	28	51.6	3.31	0.1
Greenfield	81	26	52.9	3.19	T.
Greensburg	82	26	53.0	3.90	
Hammond	78	27	17.8	3.96	.....
Hector	83	20	52.4	3.75	2.0
Holland	86	30	57.0	4.69	1.0
Huntington	78	26	48.8	4.40	3.5
Jeffersonville	85	31	56.8	2.43	0.5
Kokomo	80	26	49.2	3.52	0.5
Lafayette	78	28	49.8	4.50	0.5
Laporte	78	25	47.0	3.04	1.9
Logansport	81	25	49.6	4.09	T.
Madison	86	27	56.4	2.21	T.
Marengo	87	30	54.9	3.69	0.5
Marion	80	23	49.8	3.43	2.3
Markle	78	22	48.6	4.50	4.0
Mauzy	81	24	50.0	4.50	1.0
Moores Hill	81	28	52.6	3.16	0.4
Mount Vernon	87	28	55.4	4.14	T.
Northfield	78	21	49.3	3.66	T.
Paoli	85	29	55.2	.....	T.
Princeton	82	29	55.0	3.62	2.0
Rensselaer	78	25	48.6	3.86	0.5
Richmond	80	21	50.6	4.15	1.4
Rochester	79	25	48.8	5.04	1.0
Rockville	79	28	52.5	3.38	T.
Rome	84	27	56.4	3.98	1.2
Salem	86	27	56.0	3.47	T.
Scottsburg	84	30	56.1	2.88	0.5
Seymour	82	28	53.2	3.21	T.
Shelbyville	81	26	52.7	4.19	0.5
South Bend	78	25	46.5	3.99	6.5
Syracuse	75	22	46.0[e]	4.93	5.0
Terre Haute	.....	.....	.....	3.37	.....
Topeka	70	24	48.0	2.23	.....
Valparaiso	79	26	49.0	3.42	.....
Veedersburg	.....	.....	.....	2.83	
Indiana—Cont'd.					
Vevay	83	27	55.8	2.67	T.
Vincennes	84	31	55.4	4.15	.....
Washington	84	31	54.4	3.27	.....
Winamac	79	23	50.1	3.53	0.5
Worthington	84	29	55.4	3.70	T.
Indian Territory					
Ardmore	89	36	60.4	5.02	
Calvin	.....	.....	.....	3.99	
Chickasha	98	35	63.4	7.58	
Durant	87	37	61.3	7.58	
Fairland	90	33	58.8	1.98	
Fort Gibson	.....	.....	.....	3.75	
Goodwater	86	36	62.4	8.97	
Hartshorne	88	36	60.6	5.74	
Healdton	90	31	60.8	6.24	
Holdenville	90	37	60.0	4.54	
Marlow	87	35	59.0	6.04	
Muskogee	88	37	60.1	3.71	
Okmulgee	90	36	59.4	3.77	
Pauls Valley	90	32	59.2	6.90	
Ravia	89	38	62.6	4.61	
South McAlister	88	37	62.6	5.51	
Tulsa	.....	.....	.....	3.06	
Vinita	90	33	59.0	2.63	
Wagoner	89	36	60.2	3.23	
Webbers Falls	91[g]	25	61.0[d]	3.32	
Iowa.					
Afton	84	23	49.6	4.17	1.6
Albia	84	25	49.0	4.72	2.0
Algona	76	14	45.7	2.08	1 5
Allerton	84	20	50.0	3.31	2.6
Alta	79	17	44.8	2.52	1.0
Amana	80	25	48.8	3.22	0.1
Ames	77	20	47.4	1.33	.....
Atlantic	85	15	47.0	3.72	1.8
Audubon	81	11	46.7	3.54	2.8
Baxter	78	20	47.5	3.00	1.0
Bedford	86	19	49.8	2.84	1.8
Belleplaine	72	21	48.3	2.77	2.0
Bonaparte	84	25	50.4	4.60	3.0
Boone	77	20	46.2	3.23	T.
Britt	75	13	44.8	2.21	0.7
Buckingham	.....	.....	.....	2.40	0.2
Burlington	83	26	52.3	3.68	2.5
Carroll	83	13	46.0	2.99	T.
Cedarfalls	.....	.....	.....	2.26	
Cedar Rapids	81	28	48.8	2.34	
Chariton	83	24	49.2	4.33	1.0
Clarinda	90	18	48.6	2.91	1.5
Clearlake	72	18	46.2	1.15	1.0
Clinton	80	25	49.0	3.69	.....
College Springs	87	22	50.2	1.49	2.0
Columbus Junction	78	24	47.8	3.83	0.5
Corning	83	18	48.0	3.31	2.0
Corydon	84	22	50.6	4.60	3.5
Cresco	67	19	44.4	2.01	1.5
Creston	82	23	47.0	3.69	1.5
Cumberland	.....	.....	.....	3.52	1.0
Decorah	72	20	46.1	1.74	2.0
Delaware	71	21	45.6	2.06	0.4
Denison	81	13	46.6	2.20	1.0
Desoto	84	23	48.5	4.34	
Dows	75	14	45.0	3.16	0.5
Earlham	80	19	46.7	4.48	2.0
Elkader	76	20	47.8	2.40	0.5
Elliott	87	18	49.1	2.80	1.5
Estherville	76	15	43.6	1.50	2.0
Fayette	74	18	44.6	2.62	0.1
Florence	.....	.....	.....	2.16	0.5
Forest City	78	15	44.4	1.72	
Fort Dodge	78	14	45.6	2.93	1.0
Fort Madison	.....	.....	.....	4.22	1.0
Galva	80	14	46.1	1.98	T.
Gilman	.....	.....	.....	2.40	
Glenwood	85	22	50.4	1.80	2.0
Grand Meadow	70	18	45.8	2.19	1.0
Greene	74	14	46.4	2.81	1.0
Greenfield	85	19	48.4	4.21	1.4
Grinnell	77	22	47.7	3.48	0.5
Grundy Center	76	18	46.7	4.26	T.
Guthrie Center	78	21	47.9	4.55	3.5
Hampton	78	19	46.8	3.36	1.5
Hanlontown	74	12	44.0	2.70	1.2
Harlan	79	19	46.8	2.98	2.2
Hopeville	85	24	49.2	4.20	
Humboldt	76	15	46.8	0.94	
Ida Grove	71[e]	12	45.2[e]	1.44	T.
Independence	73	19	46.5	3.90	1.5
Indianola	85	24	49.2	3.26	1.0
Inwood	76	10	44.4	0.93	1.5
Iowa City	85	24	48.0	3.86	0.5
Iowa Falls	77	19	45.5	2.83	0.3
Keosauqua	86	25	50.4	3.98	2.2
Knoxville	84	25	50.3	3.58	1.8
Lacona	.....	.....	.....	5.43	
Lansing	73	22	47.4	2.15	1.0
Larrabee	80	10	45.6	1.29	2.2
Leclaire	.....	.....	.....	3.41	T.

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Iowa—Cont'd.	°	°	°	*Ins.*	*Ins.*
Lemars	78	14	45.5	1.25	T.
Lenox	85	21	48.8	3.68	1.2
Leon	82	24	50.3	5.49	2.5
Little Sioux	84	14	48.6	3.13	4.4
Logan	81	20	48.6	4.23	4.0
Maple Valley	.....	.....	.....	2.69	1.5
Maquoketa	80	24	47.4	3.30	0.8
Marshalltown	79	21	47.0	3.39	.....
Mason City	71	20	45.8	1.68	1.0
Massena	84	22	50.0	4.04	2.0
Monticello	.....	.....	.....	2.81	
Montezuma	.....	.....	.....	1.79	0.5
Mountayr	88	22	51.6	4.83	3.2
Mount Pleasant	82	25	50.0	4.59	2.5
Mount Vernon	83	23	49.0	2.40	T.
Muscatine	.....	.....	.....	3.41	T.
New Hampton	72	19	45.8	2.33	1.0
Newton	80	22	47.8	3.38	1.0
Northwood	73	16	44.2	0.92	2.0
Odebolt	81	17	47.0	2.83	
Ogden	79	19	47.4	2.53	0.1
Olin	76[d]	24[b]	47.6[c]	2.88	0.5
Onawa	84	18	49.0	4.24	0.9
Osage	72	16	45.3	1.77	1.0
Oskaloosa	84	25	49.6	3.34	1.8
Ottumwa	85	.....	.....	5.44	
Pacific Junction	84	19	49.2	2.31	1.5
Perry	79	21	47.9	4.13	0.8
Plover	78	14	44.9	2.93	1.0
Pocahontas	78	13	45.6	4.29	1.2
Redoak	.....	.....	.....	2.41	T.
Ridgeway	73	20	47.6	2.81	1.8
Rock Rapids	70	12	43.2	1.10	3.5
Rockwell City	80	19	46.0	4.68	1.0
Sac City	78	19	46.4	3.42	0.5
St. Charles	86	24	49.8	2.25	0.3
Sheldon	79	12	45.6	1.11	3.2
Sibley	77	10	42.9	0.63	2.1
Sidney	85	24	50.8	1.99	1.0
Sigourney	84	24	50.4	3.60	1.0
Sioux Center	75	16	45.0	1.01	2.0
Stockport	83	25	50.6	4.14	3.0
Storm Lake	78	14	43.7	2.43	0.9
Stuart	84	22	48.8	3.15	T.
Thurman	84	19	50.0	2.34	.....
Tipton	81	28	50.7	3.28	T.
Toledo	78	21	47.9	2.40	0.5
Vinton	77	22	47.6	2.22	.....
Wapello	80	28	52.0	3.84	
Washington	84	24	49.5	4.06	
Washta	81	13	46.2	2.27	T.
Waterloo	76	19	47.0	2.60	0.5
Waukee	87	21	49.4	3.60	2.5
Waverly	75	20	45.8	2.66	1.0
Webster City	77	16	47.6	1.87	T.
Westbend	76	12	45.2	3.48	1.0
Whatcheer	87[c]	22[c]	55.3[c]	2.20	T.
Whitten	72	21	46.0	3.13	1.0
Wilton Junction	82	25	49.9	4.11	2.0
Winterset	82	22	48.3	4.10	T.
Woodburn	.....	.....	.....	5.33	2.1
Zearing	79	19	46.8	2.64	T.
Kansas.					
Abilene	.....	.....	.....	2.58	
Achilles	86	14	49.6	2.46	0.5
Alton	87	19	50.8	2.15	0.6
Anthony	.....	.....	.....	1.47	.
Atchison	90	28	53.5	2.37	1.5
Baker	91	26	51.6	2.63	T.
Beloit	.....	.....	.....	2.19	7.5
Blue Rapids	.....	.....	.....	3.67	T.
Burlington	91	27	56.0	1.60	
Chapman	89	28	54.2	2.35	T.
Clay Center	90	25	53.1	3.32	
Colby	84	12	48.0	3.30	T.
Columbus	87	31	56.7	2.01	
Cottonwood Falls	90	30	55.7	2.61	
Cunningham	94	29	55.0	0.75	
Dresden	85	18	50.1	2.98	1.0
Eldorado	.....	.....	.....	1.53	T.
Ellinwood	90	28	53.2	1.75	2.1
Ellsworth	90	26	52.8	1.84	0.4
Emporia	90	29	55.0	2.17	
Englewood	88	30	54.2	4.65	T.
Enterprise	90[c]	27[c]	54.3[c]	2.13	T.
Eureka	.....	.....	.....	1.80	T.
Fall River	90	30	57.4	1.31	
Farnsworth	88	15	50.3	4.24	2.7
Forsha	92	28	54.8	3.24	T.
Fort Leavenworth	89	30	55.6	2.67	2.0
Frankfort	93	24	51.9	4.33	1.2
Garden City	86	23	51.5	5.70	T.
Gove*[1]	85	20	47.3	3.73	1.2
Grenola	90	30	54.8	1.86	
Harrison	88	15	49.7	4.22	1.2
Horton	91	26	52.8	2.39	0.6
Hoxie	85	16	50.2	3.39	T.
Hugoton	83	25	50.3	4.70	

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Kansas—Cont'd.	°	°	°	*Ins.*	*Ins.*
Hutchinson	91	29	53.8	2.05	1.0
Independence	92	34	59.0	1.18	
Iola	.....	.....	.....	1.24	
Jetmore	90[k]	20[k]	50.8[k]	2.65	T.
Jewell	90	21	51.6	3.37	1.0
La Crosse	89	25	51.9	2.06	1.0
Lakin	89	21	50.9	5.72	T.
Larned	83	25	49.1	2.17	1.0
Lawrence	88	29	54.7	1.14	0.5
Lebanon	85[e]	14[e]	46.4[e]	1.00	1.0
Lebo	90	30	55.6	1.78	T.
Lindsborg	.....	.....	.....	2.48	
Macksville	88	26	51.4	1.03	T.
McPherson	91	30	53.8	2.91	T.
Madison	91	27	54.8	1.90	
Manhattan *b*	94	27	55.6	1.90	T.
Manhattan *c*	95	27	52.8	1.68	T.
Marion	88	28	54.7	2.20	
Medicine Lodge	95	29	58.2	1.84	
Minneapolis	90	27	53.6	2.35	0.4
Moran	91	26	57.0	1.32	T.
Mounthope	87	33	55.4	2.01	
Neosho Rapids	.....	.....	.....	1.78	
Ness City	87[c]	22[c]	51.8[c]	3.25	1.0
Newton	88[c]	22[c]	53.4[c]	1.64	
Norton	87	15	48.4	2.30	1.5
Norwich	90	30	55.8	2.21	T.
Oberlin	.....	.....	.....	3.13	2.0
Osage City	90	29	53.8	1.51	
Osborne	.....	.....	.....	2.60	1.5
Oswego	88	30	57.6	1.58	
Ottawa	91	28	55.6	1.06	0.5
Phillipsburg	89	20	51.8	1.95	2.0
Pittsburg	86	31	58.2	3.00	
Plainville	88	20	50.1	2.20	2.5
Pleasanton	89	29	56.9	1.12	
Pratt	85	28	53.4	1.31	T.
Republic	89	16	50.0	4.56	0.5
Rome	93	31	56.7	2.66	
Russell	90	23	51.8	2.45	2.0
Salina	91	28	54.4	2.24	T.
Sedan	92	34	57.7	1.39	
Toronto	97	27	55.5	1.25	
Ulysses	81	24	48.2	6.10	T.
Valley Falls	92	26	53.0	0.82	0.6
Viroqua	81	25	50.8	5.15	T.
Wakeeney	89	17	51.0	2.62	.....
Wakeeney (near)	.....	.....	.....	4.10	2.4
Wallace	84	16	48.0	4.31	0.5
Walnut	90	31	57.2	1.37	
Wamego*[1]	90	30	53.1	2.05	0.2
Winfield	90	30	55.6	2.25	
Kentucky.					
Alpha	84	33	59.2	3.25	0.5
Anchorage	84	26	54.8	2.19	T.
Bardstown	85	31	56.9	2.57	0.5
Beattyville	86	24	55.0	2.85	T.
Beaver Dam	85	30	55.8	2.33	T.
Berea	84	27	56.9	3.49	1.0
Blandville	86	32	57.4	3.20	T.
Bowling Green	86	27	58.5	2.16	
Burnside	85	29	57.0	3.59	T.
Cadiz	87	27	58.3	2.62	T.
Calhoun	90	32	59.8	3.39	T.
Catlettsburg	86	30	57.5	3.22	T.
Earlington	85	27	55.9	2.98	.....
Edmonton	84	29	57.0	2.46	0.1
Eubank	83	27	53.6	3.43	0.5
Falmouth	.....	.....	.....	2.64	T.
Farmers	84	23	54.6	4.24	T.
Frankfort	82	29	56.6	2.27	T.
Franklin	85	31	59.0	2.00	
Greensburg	86	32	57.4	2.99	
High Bridge	84	23	55.8	3.20	1.5
Hopkinsville	86	24	56.4	1.87	T.
Irvington	84	32	57.1	3.02	T.
Jackson	87	27	57.6	3.33	T.
Leitchfield	82	30	56.0	3.10	0.1
Loretto	84	26	58.3	2.90	0.5
Manchester	87	26	56.4	2.80	T.
Marion	84	33	57.9	4.44	
Mayfield	85	29	58.6	4.13	T.
Maysville	86	25	53.8	2.79	T.
Middlesboro	82[g]	28[g]	55.9[g]	4.37	
Mount Sterling	82	28	55.5	4.57	0.5
Owensboro	85	31	57.0	2.72	T.
Owenton	86	29	54.0	3.18	1.0
Paducah	89	34	59.4	3.80	
Princeton	86	30	60.0	2.62	T.
Richmond	85	29	56.4	3.19	2.0
St. John	82	29	54.8	3.55	0.5
Scott	81	26	53.6	2.77	0.6
Shelby City	84	26	55.2	2.79	1.0
Shelbyville	91	29	56.4	2.39	0.2
Taylorsville	84	28	55.8	2.85	0.5
West Liberty	86	25	54.8	2.90	
Williamsburg	85	30	56.8	3.13	T.
Williamstown	83	28	54.0	2.43	

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Louisiana.	°	°	°	*Ins.*	*Ins.*
Abbeville	92	42	69.8	6.26	
Alexandria	93	40	68.7	14.21	
Amite	89	38	67.9	9.91	
Baton Rouge	86	42	67.8	5.27	
Burnside	87	41	68.4	5.73	
Calhoun	85	36	64.2	7.26	
Cameron	81	50	70.4	7.55	
Caspiana	88	44	65.9	10.62	
Cheneyville	84	42	67.1	12.97	
Clinton	84	40	67.6	13.28	
Collinston	89	41	65.0	9.08	
Covington	86	39	67.2	12.03	
Donaldsonville	.....	42	.....	6.12	
Emilie	88	43	68.2	7.25	
Farmerville	89	41	66.8	8.35	
Franklin	89	41	69.8	9.51	
Georgetown	89	39	66.4	10.68	
Grand Coteau	87	43	69.4	13.89	
Hammond	86	40	68.0	7.01	
Houma	88	39	69.0	6.75	
Jennings	86	45	68.8	7.63	
Lafayette	88	43	69.0	8.95	
Lake Charles	87	44	69.0	9.61	
Lakeside	84	48	68.8	8.90	
Lawrence	87[b]	42[f]	68.4[d]	4.20	
Leesville	87	39	67.1	11.75	
Libertyhill	90	36	66.2	5.68	
Logansport	.....	.....	.....	8.55	
Mansfield	89	40	64.9	15.27	
Melville	86	41	68.0	18.90	
Minden	90	39	64.7	11.21	
Monroe	89	41	66.2	7.09	
Morgan City	.....	.....	.....	4.26	
New Iberia	85	46	69.4	6.55	
Opelousas	87	42	68.4	11.07	
Oxford	93[c]	37[c]	66.5[c]	11.25	
Plain Dealing	88	36	65.0	8.58	
Port Eads	82	50	68.8	2.68	
Rayne	87	43	69.6	10.96	
Reserve	88	44	68.2	4.79	
Robeline	88[b]	36[a]	65.0[c]	11.46	
Ruston	90	35	65.8	8.38	
St. Francisville	89	42	68.4	10.58	
Schriever	.....	.....	.....	7.56	
Simmesport	.....	.....	.....	7.53	
Southern University	.....	.....	.....	5.15	
Sugar Experiment Station	89	45	70.4	4.80	
Sugartown	85	41	67.8	10.45	
Venice	84	41	66.8	3.47	
Maine.					
Bar Harbor	67	24	42.2	0.95	T.
Chesuncook	.....	.....	.....	0.71	3.0
Cornish	69	19	41.6	1.97	1.2
Danforth	.....	.....	.....	1.40	T.
Fairfield	75	22	41.7	2.15	
Farmington	76	19	42.0	2.12	T.
Gardiner	73	22	41.3	2.10	1.2
Houlton	70	20	41.8	1.25	2.0
Lewiston	75	24	42.4	1.54	0.1
Madison	70	20	42.0	2.59	
Mayfield	69	16	39.2	2.17	3.0
Millinocket	70	20	40.2	2.05	0.5
North Bridgton	75	21	42.4	1.65	T.
Oquossoc	69	12	37.1	1.91	
Orono	74	21	42.7	2.22	T.
Patten	70	19	40.4	2.50	
Rumford Falls	71	23	41.4	2.11	T.
The Forks	.....	.....	.....	1.68	4.5
Thomaston	66	22	39.6	1.50	T.
Vanburen	65	18	38.6	1.08	1.5
Winslow	74	21	42.3	2.20	
Maryland.					
Annapolis	78	31	53.4	4.30	T.
Bachmans Valley	78	26	49.8	3.75	T.
Boettcherville	88	21	54.1	1.07	1.2
Cambridge	87	29	56.0	2.87	T.
Cheltenham	87	25	53.7	2.70	T.
Chestertown	78	29	51.8	3.36	T.
Chewsville	76	22	50.6	2.10	T.
Clearspring	79	26	51.6	1.23	T.
Coleman	81	30	53.2	4.26	T.
Collegepark	87	27	55.8	2.75	T.
Colora	.....	.....	.....	3.22	T.
Cumberland	.....	.....	.....	1.65	1.2
Darlington	80	25	51.6	3.10	T.
Deerpark	78	8	46.0	1.75	12.0
Denton	84	25	52.0	2.06	T.
Easton	82	29	53.4	2.38	
Fallston	81	27	51.4	3.70	T.
Frederick	83	25	53.6	1.60	T.
Grantsville	76	16	47.1	1.71	7.5
Greatfalls	84	22	53.7	2.04	
Greenspring Furnace	79	23	52.3	1.18	T.
Hancock	80	20	52.3	1.48	T.
Harney	.....	.....	.....	3.03	T.
Jewell	83	31	54.0	3.87	T.
Johns Hopkins Hospital	81	33	55.1	2.82	
Keedysville	80	22	53.0	1.58	T.

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Maryland—Cont'd.	°	°	°	*Ins.*	*Ins.*
Laurel	83	28	53.8	4.52	T.
McDonogh	......	......	......	5.60	
Mount St. Marys College	77	30	53.4	2.21	T.
New Market	80	27	52.4	2.72	T.
Oakland	76	8	46.6	2.22	9.0
Pocomoke City	82	32	54.8	5.21	
Porto Bello	79	29	54.0	3.99	T.
Prince Fredericktown	86	30	55.6[f]	2.97	T.
Princess Anne	83	27	53.6	2.95	
Solomons	83	34	54.6	2.58	T.
Sudlersville	83	29	53.4	3.02	T.
Takoma Park	83	27	52.9	3.47	T.
Van Bibber	78	29	51.9	4.52	T.
Westernport	80	23	51.1	1.18	0.2
Woodstock	80	27	53.5	2.85	T.
Massachusetts.					
Amherst	79	22	46.0	2.56	T.
Bedford	78	26	46.6	2.34	......
Bluehill (summit)	72	26	44.4	3.35	T.
Cambridge	75	27	47.6	2.63	......
Chestnuthill	77	27	47.8	3.08	
East Templeton *[1]	74	26	46.7	1.28	1.0
Fall River	68	28	45.4	2.21	T.
Fitchburg	77	27	46.2	2.28	T.
Framingham	78	24	48.2	2.66	
Groton	77	23	44.6	2.41	2.0
Hyannis	......	......	......	1.33	
Jefferson	......	......	......	2.39	T.
Lawrence	68	26	45.0	2.05	T.
Leominster	......	......	......	2.14	T.
Lowell	77	27	47.8	2.15	......
Ludlow Center	71	17	41.4	2.70	......
Middleboro	72	23	45.0	2.05	T.
Monson	75	23	45.7	2.56	1.0
New Bedford	67	29	46.0	1.61	
Pittsfield	......	......	......	1.79	
Plymouth *[1]	73	32	46.4	2.34	T.
Princeton	......	......	......	2.54	
Provincetown	70	30	44.4	1.79	
Salem	......	......	......	2.79	
Somerset *[1]	72	24	47.4	2.63	
Sterling	......	......	......	2.62	
Taunton	71	23	44.6	2.98	T.
Webster	......	......	......	2.91	0.2
Westboro	79	26	48.0	2.94	T.
Weston	76	25	45.4	2.86	T.
Williamstown	73	26	44.4	1.89	......
Winchendon	......	......	......	2.02	
Worcester	77	27	46.5	2.46	T.
Michigan.					
Adrian	77	19	45.6	2.04	......
Agricultural College	76	22	44.6	1.49	2.0
Allegan	82[g]	24[g]	45.7[g]	2.12	
Alma	78	24	44.6	3.15	4.5
Ann Arbor	76	24	44.8	2.80	0.5
Arbela	77	23	43.6	2.86	0.5
Baldwin	78	14	42.7	......	......
Ball Mountain	75	16	42.8	2.60	2.1
Baraga	......	......	......	0.85	6.0
Battlecreek	75	22	43.0	2.67	0.5
Bay City	75	24	43.2	1.31	2.0
Benzonia	71	22	40.9	1.21	1.5
Berlin	75	19	42.8	2.04	2.9
Berrien Springs	81[d]	24[d]	46.2[d]	3.27	2.0
Big Rapids	77	20	41.1	2.31	2.0
Birmingham	75	23	44.0	......	......
Bloomingdale	80	21	45.8	3.12	1.0
Calumet	67	20	38.2	1.30	5.5
Cassopolis	78	23	47.0	2.95	1.5
Charlevoix	62[g]	22[g]	38.2[g]	......	1.5
Charlotte	84	21	46.3	1.30	1.0
Chatham	69	9	35.4	1.55	9.9
Cheboygan	80	19	39.1	0.50	2.0
Clinton	77	21	44.8	3.10	1.0
Coldwater	78	21	47.2	3.54	2.0
Concord	77	21	45.0	2.90	2.0
Deer Park	62	19	35.0	0.95	T.
Detour	66	21	36.6	1.42	1.0
Dundee	76	22	45.4	3.39	0.5
Eagle Harbor	67	22	36.1	1.04	......
East Tawas	69	22	41.6	3.43	2.0
Eloise	78	22	45.6	1.86	T.
Ewen	75	10	36.2	1.40	3.0
Fennville	79[f]	21	45.6[f]	2.90	2.0
Fitchburg	76	21	44.0	2.94	2.5
Flint	77	21	43.7	2.55	1.0
Gladwin	85	21	42.6	3.20	1.0
Grand Haven	73	22	42.8	1.65	1.6
Grand Marais	60	22	36.4	0.65	1.0
Grape	77	20	44.9	2.98	0.7
Grayling	77	18	40.4	2.45	5.0
Hagar	72	22	44.4	3.40	2.0
Harbor Beach	69	24	42.0	0.70	T.
Harrison[a]	79	19	42.4	......	......
Harrisville	65	21	39.8	3.11	1.7
Hastings	79	23	45.6	2.67	0.5
Hayes	77	24	42.6	1.03	6.0
Highland	......	......	......	2.85	6.0
Michigan—Cont'd.	°	°	°	*Ins.*	*Ins.*
Hillsdale	76	28	45.6	3.63	4.0
Howell	75	20	43.6	2.19	1.0
Humboldt	70	7	34.6	1.00	8.0
Iron Mountain	72	19	39.8	1.24	2.0
Iron River	75	12	36.9	3.05	7.0
Ironwood	73	19	39.0	2.34	5.1
Ishpeming	72	14	36.0	1.03	6.5
Ivan	77	16	40.0	1.61	3.5
Jackson	78	23	46.3	3.23	0.5
Jeddo	75	24	42.2	2.13	0.9
Kalamazoo	78	24	46.0	2.73	1.0
Lansing	77	23	45.4	2.51	0.4
Lapeer	79	22	44.8	1.52	3.2
Ludington	64	25	43.5	......	......
Mackinac Island	60	22	37.2	1.16	5.2
Mackinaw City	60	22	37.8	1.80	4.0
Manistee	80	21	43.6	......	......
Menominee	68	21	40.3	1.88	0.8
Midland	78	24	42.6	1.40	2.6
Montague	70	24	43.2	1.54	T.
Muskegon	72	21	43.4	1.55	4.0
Old Mission	76	25	40.2	1.05	T.
Olivet	76	24	44.6	3.24	1.6
Omer	......	......	......	3.38	2.0
Onaway	73	21	39.4	......	......
Ontonagon	......	22	......	1.20	7.0
Ovid	76	21	44.2	2.29	T.
Owosso[d]	81	19	45.1	......	1.0
Petoskey	78	24	39.2	0.45	2.0
Plymouth	78	18	45.0	2.35	1.0
Port Austin	79	22	40.2	......	3.0
Powers	78	20	41.5	......	7.0
Reed City	77	21	41.6	1.92	1.0
Saginaw (W. S.)	78	24	44.2	2.36	2.8
St. Ignace	66	20	37.4	......	......
St. Johns	79	23	47.1	2.68	3.5
St. Joseph	75	......	......	......	......
Slocum	76	23	42.6	2.05	2.7
Somerset	74	20	43.8	......	1.0
South Haven	78	23	43.8	3.12	3.0
Stanton	78	20	43.4	......	3.5
Thomaston	76	10	37.6	1.70	5.0
Thornville	78	26	44.1	2.94	4.0
Traverse City	68	16	36.2[d]	1.06	1.5
Vassar	78	25	45.2	2.15	T.
Wasepi	79	25	46.2	3.20	0.5
Waverly	78	25	46.8	......	......
Webberville	75	22	44.0	2.84	5.2
Wetmore	68	9	34.8	2.10	16.0
Whitefish Point	57	19	32.9	1.44	0.2
Ypsilanti	77	20	43.7	2.95	1.2
Minnesota.					
Albert Lea	72	20	45.6	1.07	1.0
Alexandria	75	18	41.1	2.75	1.0
Amboy	75	12	44.9	1.05	3.0
Angus	77	18	39.7	1.30	
Ashby	73	19	41.8	1.43	2.0
Beardsley	75	17	42.7	1.69	T.
Beaulieu	76[d]	11[d]	37.4[d]	1.93	T.
Bemidji	77	12	39.4	......	T.
Bird Island	76	20	44.8	1.02	T.
Caledonia	72	18	44.0	0.48	2.0
Campbell	77	18	41.1	1.69	2.0
Collegeville	70	21	43.4	1.63	T.
Crookston	75	18	39.0	1.27	T.
Detroit	76	13	37.5	1.78	T.
Faribault	73	18	44.6	1.25	T.
Farmington	74	21	43.8	0.76	T.
Fergus Falls	73	22	42.4	2.16	3.0
Floodwood	76	15	38.8	2.88	......
Grand Meadow	73	13	44.0	0.80	2.5
Hallock	79	12	38.4	0.44	......
Hinckley	73	16	41.6	0.84	0.6
Hovland	62	15	35.1	2.65	10.0
Lake Winnibigoshish	70	15	36.4	2.49	1.3
Leech	72	15	37.0	2.08	......
Long Prairie	75	15	41.4	2.23	2.0
Luverne	74	16	43.4	0.76	4.5
Lynd	71[d]	15[d]	43.0[d]	0.99	1.0
Mankato	......	......	......	1.24	1.5
Mapleplain	75	21	44.4	0.78	T.
Milaca	......	16	36.9[e]	1.61	1.0
Milan	75	16	43.4	0.47	......
Montevideo	74	19	44.0	0.91	T.
Mora	73	16	41.5	2.09	1.0
Morris	74	20	41.4	1.78	......
Mount Iron	75	10	37.6	3.97	0.5
New London	74	17	43.2	1.02	......
New Richland	74	16	45.6	1.25	1.0
New Ulm	75	22	45.0	1.06	0.5
Park Rapids	72	17	37.2	2.18	7.8
Peterson	......	......	......	1.12	0.3
Pine River	74	10	38.4	2.75	T.
Pokegama Falls	75	7	34.6	3.07	4.8
Pratt	73	17	46.6	1.04	1.5
Redwing	73	24	45.2	0.38	T.
Reeds	......	......	......	0.28	......
St. Charles	72	20	44.4	0.74	1.1
Minnesota—Cont'd.	°	°	°	*Ins.*	*Ins.*
St. Cloud	73	19	44.3	2.06	T.
St. Peter	72	20	45.6	1.30	T.
Sandy Lake Dam	74	14	38.8	3.21	
Shakopee	73	20	45.5	0.93	
Tonka	......	......	......	0.97	......
Two Harbors	72	17	40.6	2.69	0.2
Wabasha	78	23	46.7	0.69	T.
Willow River	77	12	38.7	2.32	0.5
Winnebago	76	14	45.1	1.62	2.5
Winona	71	26	45.4	0.54	1.2
Worthington	76	18	43.9	0.59	1.8
Mississippi.					
Aberdeen	88	32	62.0	6.38	
Agricultural College	87	36	63.9	7.58	
Austin	86	34	62.9	6.97	
Batesville	86	33	61.2	6.19	
Bay St. Louis	88	45	69.2	4.44	
Biloxi	87	44	70.0	3.69	
Booneville	84	31	61.6	3.60	
Brookhaven	87	40	67.0	10.45	
Canton	85	35	64.6	6.50	
Columbia	88	36	67.4	8.84	
Columbus	86	32	62.0	6.63	
Corinth	84	31	59.8	4.30	
Crystal Springs	89	38	65.5	9.87	
Duck Hill	86	32	62.3[e]	8.36	
Edwards	83	35	63.0	9.10	
Enterprise	......	......	......	7.45	
Fayette	84	39	65.6	11.30	
Fayette (near)	......	......	......	10.84	
Greenville *a*	88	38	64.4	7.73	
Greenville *b*	89	40	64.8	8.04	
Greenwood	87	36	62.8	6.77	
Hattiesburg	......	......	......	7.96	
Hazlehurst	85	38	64.7	10.50	
Hernando	86	35	61.4	7.33	
Holly Springs	84	35	60.4	5.37	
Indianola	84	38	63.8	7.93	
Jackson	85	37	65.3	7.72	
Kosciusko	86	34	62.8	9.25	
Lake	86	33	62.6	8.52	
Lake Como	87	34	63.2	8.90	
Laurel	88	36	65.8	8.21	
Leakesville	89	35	66.4	4.40	
Louisville	87	34	62.8	7.21	
Macon	88	34	63.8	4.90	
McNeill	......	......	......	11.59	
Magnolia	88	36	67.6	14.59	
Merrill	......	......	......	8.53	
Natchez	89	46	70.1	8.27	
Nitta Yuma	87	39	64.0	5.86	
Okolona	87	30	60.4	4.47	
Patmos	......	......	......	9.95	
Pearlington	89	39	67.1	6.12	
Pecan	87	39	68.0	4.51	
Pittsboro	86	31	62.0	6.93	
Pontotoc	84	32	61.0	4.32	
Poplarville	85	38	67.4	6.53	
Port Gibson	86	35	65.8	9.96	
Porterville	86	32	64.0	5.40	
Quitman	85	35	65.3	8.51	
Ripley	86	25	61.2	5.20	
Shelby	86	36	63.6	8.03	
Shoccoe	88	36	65.2	7.61	
Shubuta	......	......	......	7.88	
Stonington	......	......	......	9.83	
Suffolk	87	36	67.1	10.48	
Swan Lake	87	......	......	6.63	
Tchula	87	30	64.6	8.60	
Tupelo	87	31	61.8	4.99	
University	86	31	62.2	9.36	
Walnutgrove	85[e]	34[e]	64.2[e]	4.02	
Watervalley	85	32	61.2	7.85	
Waynesboro	90	34	67.2	5.73	
Woodville	92	40	69.8	9.74	
Yazoo City	85	38	64.6	7.28	
Missouri.					
Albany	......	......	......	4.06	
Appleton City	88	29	55.6	2.65	
Arlington	......	......	......	1.50	
Arthur	89	27	56.2	1.67	T.
Avalon	88	26	52.6	3.81	
Bagnell	......	......	......	0.79	
Bethany	85	22	50.6	5.82	0.1
Birchtree	87	32	59.2	2.99	T.
Bismarck	......	......	......	0.07	T.
Blue Springs	88	27	54.4	3.06	1.5
Boonville	......	......	......	1.92	
Brunswick	90	27	53.0	4.31	0.8
Cape Girardeau	......	......	......	2.63	
Caruthersville	89	27	60.4	3.52	T.
Conception	89	24	51.9	3.17	T.
Darksville	87	21	53.6	2.19	0.5
Dean	91	30	59.3	3.49	
De Soto	88	31	56.6	3.70	
Doniphan	86	28	58.9	4.48	
Downing	......	......	......	5.27	1.5
Fairport	......	......	......	5.30	1.5

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
	°	°	°	*Ins.*	*Ins.*
Missouri—Cont'd.					
Fayette	88	27	52.6	2.69	0.5
Fulton	90	25	54.2	2.55	T.
Gallatin *[1]	84	28	54.7	3.79	0.5
Gano	89	29	57.0	2.32	T.
Glasgow	89	28	54.7	2.55	1.0
Goodland	85	20	54.4	4.11	0.2
Gorin	......	......	......	3.07	1.0
Grant City	88	25	52.2	3.32	1.5
Harrisonville	88	27	55.6	2.01	0.5
Hazlehurst	......	......	......	3.67	0.5
Hermann	......	......	......	3.14	T.
Houston	87	22	55.8	2.19	T.
Huntsville	90	28	55.4	3.46	T.
Ironton	87	21	54.9	4.53	T.
Jackson	87	25	57.8	3.88	
Jefferson City	91	28	55.9	1.12	
Joplin	90	32	58.9	1.69	
Kidder	87	27	51.5	3.57	1.2
Koshkonong	87	32	58.2	5.70	
Lamar	88	29	56.4	1.82	
Lamonte	......	......	......	2.01	T.
Lebanon	89	28	56.2	1.85	
Lexington	90	29	55.1	3.45	1.5
Liberty	89	28	54.2	2.54	1.2
Lockwood	85	29	55.4	2.14	T.
Louisiana	90	24	53.2	2.76	0.6
Macon	90	27	54.4	4.53	1.5
Marblehill	89	25	58.0	3.13	
Marshall	89	26	51.8	2.16	
Maryville	90	24	50.5	3.19	1.0
Mexico	90	26	54.4	5.12	0.3
Monroe	88	27	52.6	3.41	0.1
Montreal	91	23	55.2	2.35	T.
Mountaingrove	86	26	56.0	3.16	T.
Mount Vernon [1]	90	30	56.7	2.73	.....
Neosho	89	30	57.8	2.58	
New Haven	90	30	56.4	2.55	T.
New Madrid	......	......	......	3.79	
New Palestine	91	30	55.6	2.48	T.
Oakfield	88	31	56.3	3.53	
Olden	91	24	58.7	4.23	T.
Oregon	89	24	52.6	3.18	1.5
Osceola	......	......	......	2.23	
Pine Hill	......	......	......	4.29	T.
Princeton	86	26	51.9	4.44	1.0
Protem	90	33	59.5	2.74	T.
Rockport	......	......	......	2.46	
Rolla	......	......	......	3.23	T.
St. Charles	89	28	55.6	2.74	
St. Joseph	......	......	......	2.50	T.
Sarcoxie	......	......	......	2.13	
Sedalia	90	28	55.8	2.45	T.
Seymour	87	28	55.8	2.53	
Sikeston	86	28	58.2	4.20	
Steffenville	85	28	52.4	2.56	
Sublett	84	26	51.6	7.79	1.0
Trenton	84	28	52.8	4.45	T.
Unionville	84	22	49.8	5.86	2.0
Versailles	92	29	57.8	3.88	T.
Warrensburg	92	28	56.6	2.53	0.9
Warrenton	90	29	54.2	3.80	T.
Warsaw	91	21	55.0	1.72	T.
Wheatland	......	......	......	1.43	T.
Willowsprings	87	23	55.6	4.47	T.
Windsor	91	27	55.8	0.89	0.5
Zeitonia	87	26	56.6	1.93	T.
Montana.					
Absarokee	......	......	......	2.34	9.5
Adel	67	0	39.0	1.11	8.0
Alzada	......	......	......	0.75	......
Anaconda	70	15	41.2	0.42	4.0
Augusta	73	4	41.2	1.78	10.0
Billings *	80	20	50.6	0.89	3.7
Boulder	71	16	41.9	0.77	2.1
Bozeman	71	18	44.4	0.80	4.8
Butte	65	18	42.2	0.85	......
Canyon Ferry	75	19	45.7	0.42	0.5
Cascade	76	14	45.5	0.84	11.5
Chester	76	9	41.8	0.17	1.5
Chinook	83[f]	11[f]	45.1[f]	......	......
Choteau	72	11	41.6	0.55	5.1
Clearcreek	78	16	44.2	0.90	6.0
Columbia Falls	76	15	44.0	0.45	1.5
Copper	......	......	......	1.22	2.5
Crow Agency	77	22	45.5	1.75	8.0
Culbertson	83	3	40.8	T.	......
Dayton	74	25	48.8	0.90	0.2
Decker	79	11	44.2	1.05	1.5
Deerlodge	70	16	43.3	......	......
Dillon	70	17	42.2	3.00	10.8
Ekalaka	78	14	42.2	0.38	......
Fallon	82	11	44.7	T.	T.
Forsyth	83	17	46.0	0.41	2.0
Fort Benton	76	18	43.1	......	......
Fort Harrison	74	17	43.0	......	......
Fort Logan	72	15	39.4	......	......
Glendive	80	4	41.3	T.	......
Gold Butte	......	......	......	1.40	7.0
Grayling	58	−1	33.8	0.49	2.0
Greatfalls	74	19	44.6	0.68	......
Hamilton	74	25	48.4	1.21	......
Hayden (near)	79	18	45.6	0.32	1.8
Highwood	......	......	......	1.50	T.
Homepark	......	......	......	1.09	
Lakeview	......	......	......	1.30	2.0
Lame Deer	78	20	43.0	1.00	2.0
Lewistown	75	13	42.6	1.10	10.0
Livingston	74	20	43.6	1.11	12.0
Lodgegrass	81[c]	19	43.8[c]	2.22	3.8
Marysville	65	12	38.6	1.32	12.0
Missoula	75	20	47.7	0.46	
Neihart	......	......	......	1.24	12.0
Nye	......	......	......	3.27	20.5
Ovando	70	12	41.4	0.75	2.5
Parrot	74	20	45.2	......	......
Philipsburg	86	13	44.4	0.61	0.2
Plains	76	20	46.0	0.35	T.
Poplar	83	3	42.4	0.00	
Redlodge	69[e]	6	38.4[e]	2.76	36.0
Ridgelawn	88	4	43.6	0.00	
St. Pauls	77	15	43.6	0.48	4.0
St. Peter	69	8	41.2	1.62	11.5
Saltese	......	......	......	1.20	
Springbrook	81	5	43.4	T.	T.
Steele	......	......	......	1.75	6.0
Toston	75	19	46.4	......	......
Townsend	......	......	......	0.48	2.0
Troy	84	19	47.8	0.65	5.0
Twin Bridges	75	13	43.4	1.10	1.0
Utica	69	11	40.8	0.75	6.8
Virginia City	67	17	41.5	0.78	2.5
Warrick	......	......	......	1.13	11.3
Whitlash	......	......	......	0.45	T.
Wolf Creek	72	15	42.6	1.09	0.5
Wolf Point	......	......	......	T.	
Wolsey	64	4	36.0	0.85	7.5
Yale	74	15	42.4	0.70	5.0
Nebraska.					
Agate	79	1	41.2	2.73	......
Agee *[1]	79	20	43.4	2.62	3.0
Albion	79	16	46.2	4.72	3.0
Alliance	87	12	44.6	3.83	......
Alma	88	16	49.5	2.71	1.2
Ansley	86	12	46.1	8.41	3.5
Ashland a	81	21	50.2	5.17	0.1
Ashton	......	......	......	3.93	......
Auburn	90	23	49.2	1.96	1.0
Aurora	83	15	48.6	4.33	1.0
Bartley	92	14	49.8	3.09	2.0
Beaver	87	18	50.2	2.90	2.6
Bellevue	......	......	......	3.44	1.1
Benkleman	......	......	......	2.39	7.0
Bethany	......	......	......	4.20	1.6
Blair	81	19	48.4	5.47	2.8
Bluehill	......	......	......	5.28	2.2
Bradshaw	......	......	......	4.85	3.1
Bridgeport	84	14	44.0	4.74	2.0
Broken Bow	84	10	45.6	5.59	0.2
Burchard	......	......	......	2.83	......
Burge	......	......	......	3.36	5.4
Burwell	......	......	......	4.56	T.
Callaway	87	9	46.6	3.50	0.1
Central City	......	......	......	4.11	2.0
Chester	......	......	......	4.39	......
Cody	......	......	......	1.91	5.0
Columbus	85	13	47.4	3.91	4.0
Crawford	......	......	......	3.57	7.5
Crete	84	21	50.7	2.41	0.5
Culbertson	84	18	49.4	3.04	2.0
Curtis	89	16	46.0	3.78	3.0
David City	80	19	47.4	4.77	3.5
Dawson	91	23	52.8	2.74	0.5
Duff	......	......	......	3.80	5.0
Dunning	......	......	......	5.10	3.5
Edgar	......	......	......	5.75	3.0
Ericson	......	......	......	4.35	3.0
Ewing	......	......	......	3.47	0.5
Fairbury	91	18	45.6	3.28	2.0
Fairmont	83	14	47.2	3.50	1.0
Fort Robinson	74	10	39.3	0.78	7.2
Franklin	87	15	49.8	3.27	......
Fremont	82	17	48.6	4.48	3.0
Fullerton	......	......	......	5.52	4.5
Geneva	86	15	49.7	3.99	2.0
Genoa (near)	81	18	48.6	4.39	5.5
Gering	82	19	44.7	4.41	......
Gordon	......	......	......	1.91	4.1
Gothenburg	87	12	47.3	3.11	T.
Grand Island	84	15	49.2	4.01	4.0
Grant	83	16	45.6	3.61	......
Guide Rock	......	......	......	4.16	2.0
Haigler	......	......	......	2.48	......
Halsey	83	22	46.3	6.71	......
Hartington	78	14	42.4	2.04	T.
Harvard	80	12	46.8	4.40	T.
Hastings *[1]	82	20	47.9	4.06	3.0
Hayes Center	......	......	......	4.46	3.5
Hay Springs	81	15	42.8	3.07	6.0
Hebron	87	18	49.6	4.42	2.0
Hendley	......	......	......	2.66	......
Hickman	......	......	......	4.15	......
Holbrook	......	......	......	3.62	1.0
Holdrege	84	13	49.5[c]	4.80	T.
Holly	......	......	......	2.45	4.0
Hooper *[1]	80	24	47.0	4.73	3.0
Imperial	75	16	44.5	3.55	13.5
Johnstown	......	......	......	1.88	......
Kearney	86[b]	11	49.8[d]	3.85	1.4
Kennedy	81	4	43.6	3.36	8.0
Kimball	80	17	42.3	5.57	11.6
Kirkwood	81	15	46.0	2.08	4.0
Leavitt	86	12	48.0	4.62	2.1
Level	......	......	......	2.72	2.6
Lexington	87	8	47.2	4.19	2.5
Lodgepole	85	18	44.2	3.62	9.0
Loup	86	11	46.6	4.18	......
Lynch	86	15	47.2	2.56	......
McCook	......	......	......	3.28	1.0
McCool	......	......	......	4.97	......
Madison	76	20	46.2	4.36	2.0
Marquette	......	......	......	5.50	1.5
Mason	......	......	......	6.82	......
Merriman	......	......	......	2.70	5.5
Minden	85	10	46.8	3.89	2.0
Monroe	......	......	......	4.23	4.0
Nebraska City	82	20	51.2	1.75	3.0
Nemaha	......	......	......	0.97	
Norfolk	83	17	47.4	3.83	2.0
North Loup	86	12	47.3	4.59	3.5
Oakdale	78	18	45.4	2.60	1.5
Odell	......	......	......	4.87	T.
Ord	......	......	......	4.70	......
Osceola	......	......	......	3.89	3.8
Palmer	......	......	......	3.94	2.0
Palmyra *[1]	82	24	49.8	2.05	1.0
Pawnee City	90	23	51.1	2.86	2.0
Plattsmouth	......	20	......	2.20	......
Plymouth	87	22	51.4	2.54	0.2
Purdum	79	4	44.2	5.50	6.0
Ravenna	84	11	47.6	3.97	2.6
Redcloud	85	18	47.7	4.03	......
Republican	......	......	......	3.20	0.5
Rulo	......	......	......	2.62	1.0
St. Libory	......	......	......	4.00	2.0
St. Paul	86	15	48.8	4.15	3.0
Santee	80	18	47.6	1.91	0.5
Schuyler	......	......	......	3.71	4.0
Seneca	......	......	......	2.96	......
Seward	78	20	48.6	4.85	2.5
Smithfield	......	......	......	4.34	......
Springview	79	14	45.9	1.69	4.0
Stanton	81	16	47.2	3.88	1.5
Strang	......	......	......	3.99	1.5
Stratton	......	......	......	3.80	......
Stromsburg	......	......	......	3.96	......
Superior	84	5	45.6	3.62	......
Syracuse	......	......	......	3.20	......
Tablerock	......	......	......	2.20	1.0
Tecumseh	......	......	......	2.02	......
Tekamah	83	20	48.4	5.86	5.0
Turlington	83	22	50.8	1.82	1.5
University Farm	83	22	50.2	3.55	......
Wahoo	......	......	......	4.18	1.0
Wakefield	79	16	45.0	3.34	0.9
Wallace	......	......	......	2.80	3.0
Wauneta	......	......	......	3.86	3.0
Weeping Water	......	......	......	1.61	1.0
Westpoint	83	18	47.4	5.09	......
Whitman	......	......	......	3.26	4.0
Wilber	......	......	......	2.71	2.0
Wilsonville	......	......	......	3.75	2.0
Winnebago	83	11	46.0	4.45	T.
Wisner	......	......	......	3.30	1.0
Wymore	......	......	......	......	1.0
York	82	16	48.3	3.77	1.2
Nevada.					
Amos	78	18	48.0	0.33	
Austin	68	19	44.6	0.91	
Battle Mountain	......	20	......	T.	
Belmont	66	22	42.8	0.29	2.0
Beowawe *[1]	75	35	51.1	T.	
Candelaria	75	26	49.2	T.	
Carlin *[1]	68	25	43.8	......	......
Carson City	73	23	48.5	1.12	4.1
Cranes Ranch	......	......	......	1.45	7.6
Dyer	79	18	49.4	0.10	1.0
Elko	74	26	45.2	0.23	0.2
Eureka	69	10	40.6	2.23	12.5
Geyser	75	12	44.8[d]	0.42	0.5
Golconda	......	......	......	0.35	
Halleck *[5]	66	22	46.8	......	......
Hawthorne	77	20	46.8	0.00	
Humboldt	72	30	51.4	0.10	
Lewers Ranch	75	20	50.6	2.40	3.0

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Nevada—Cont'd.	°	°	°	*Ins.*	*Ins.*
Lovelocks	79	25	51.1	0.15	
Martins	.....	.....	.....	0.88	3.0
Mill City *[1]	64	32	45.2	0.40	
Palisade	74	21	47.1	0.97	
Palmetto	72	15	43.8	0.75	5.5
Pioche	83	13	45.0	0.97	3.0
Potts	73	14	43.6	2.35	6.8
Reno State University	72	25	48.2	1.46	4.5
San Jacinto	77	15	44.8	0.89	2.0
Sodaville	.....	.....	.....	0.00	
Tecoma	74	16	47.2	0.38	1.0
Toano	.....	.....	.....	0.68	1.0
Wabuska	83	18	51.1	0.35	
Wadsworth	82	26	54.4	.....	1.0
Wells*[1]	62	22	44.6	.....	2.0
Wood	70	20	45.8	0.74	
New Hampshire.					
Alstead	72	22	42.1	.....	.....
Bartlett	.....	.....	.....	2.60	1.0
Berlin Mills	68	18	40.2	2.30	3.0
Bethlehem	67	17	39.0	2.04	3.5
Bretton Woods	.....	.....	.....	1.88	.....
Brookline*[1]	74	24	46.2	2.38	0.2
Chatham	71	15	38.8	2.00	.....
Durham	76	21	43.4	1.13	
Franklin Falls	.....	.....	.....	1.84	T.
Grafton	73	18	40.9	1.52	
Hanover	74	22	41.8	1.96	0.1
Keene	75	16	43.6	1.40	T.
Nashua	79	25	46.6	2.35	1.0
Newton	77	23	43.7	2.59	T.
North Woodstock	.....	.....	.....	3.06	.....
Plymouth	72	22	41.5	1.83	T.
Stratford	70	19	39.5	1.82	2.0
New Jersey.					
Asbury Park	74	28	48.3	3.19	T.
Bayonne	81	30	50.0	2.72	T.
Belvidere	79	25	50.6	2.05	.....
Bergen Point	81	28	49.6	2.87	T.
Beverly	80	28	50.9	3.86	0.2
Blairstown	78	23	49.8	2.16	.....
Bridgeton	83	26	53.2	3.88	T.
Canton	.....	.....	.....	3.45	T.
Cape May C. H	78	27	50.9	3.91	T.
Charlotteburg	74	19	47.0	1.82	T.
Chester	76	22	47.4	2.06	0.5
Clayton	79[f]	25[f]	49.8[f]	3.46	
College Farm	82	27	.....	2.83	T.
Dover	75	24	46.6	2.16	T.
Elizabeth	82	29	51.6	2.95	.....
Englewood	81	29	49.8	2.81	0.3
Flemington	79	24	50.2	2.71	T.
Friesburg	81	25	51.2	3.63	T.
Hightstown	82	24	49.6	2.77	T.
Imlaystown	81	27	51.2	2.96	0.2
Indian Mills	84	23	51.0	3.27	T.
Lakewood	82	25	50.0	2.90	T.
Lambertville	80	26	51.0	2.71	T.
Layton	78	18	46.8	1.53	T.
Moorestown	80	26	50.8	3.12	0.6
Newark	81	29	50.4	2.49	T.
New Brunswick	80	27	51.5	3.02	T.
Newton	75[d]	24[d]	48.5[d]	2.33	T.
Oceanic	78	28	49.6	3.26	T.
Paterson	82	29	52.0	2.66	T.
Phillipsburg	77	28	50.5	1.70	0.1
Pleasantville	.....	.....	.....	3.65	.....
Rancocas	.....	.....	.....	3.49	0.8
Rivervale	75	20	47.6	2.27	.....
Sandyhook	77	31	48.4	4.03	0.3
Somerville	82	23	50.0	2.57	T.
South Orange	78	27	49.0	2.51	T.
Sussex	77	24	49.0	1.73	T.
Toms River	82	21	49.6	2.78	T.
Trenton	78	33	52.8	2.80	T.
Vineland	81	26	50.6	3.84	T.
Woodbine	78	25	50.2	2.60	
Woodstown	.....	.....	.....	3.31	.....
New Mexico.					
Alamagordo	81	31	56.9	3.34	
Albert	80	28	53.0	4.53	T.
Albuquerque	75	29	51.2[e]	4.20	.....
Alma	79	28	53.4[d]	2.40	2.0
Arbela	75	28	51.6	1.98	
Bellranch	80	25	52.2	4.15	T.
Bloomfield	78	24	49.8	3.07	0.2
Brice	79	31	57.2	1.83	
Cambray	.....	.....	.....	0.55	
Carlsbad	89[f]	32[g]	60.0[g]	2.07	
Cimarron	73	21	46.6	4.45	.....
Cloudcroft	56	14	37.1	3.85	34.0
Deming	80	29	54.4	1.87	T.
Dorsey	74	21	45.1	4.97	2.0
Eagle Rock Ranch	73	21	44.4	5.90	2.3
Elizabethtown	64	6	37.5	3.55	13.0
Elk	.....	.....	.....	2.55	T.
Engle	78	30	53.4	1.30	
Estancia	68	23	46.9	2.69	6.0

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
New Mexico—Cont'd.	°	°	°	*Ins.*	*Ins.*
Fairview	85	21	52.9	2.30	8.0
Fort Bayard	73	22	49.4	2.93	.....
Fort Stanton	73	25	47.1	2.04	
Fort Union	73	17	44.9	3.30	.....
Fort Wingate	74	24	45.4	4.05	.....
Fruitland	81	24	50.8	2.39	0.2
Gage	.....	.....	.....	1.78	.....
Las Vegas	73	17	46.4	3.07	3.5
Lordsburg	88	30	58.9	1.27	.....
Los Lunas	86	32	55.1	2.65	
Luna	77	19	46.8	2.37	5.5
Magdalena	.....	.....	.....	4.56	6.0
Mesilla Park	82	31	57.0	1.89	T.
Mineral Hill	.....	.....	.....	3.54	7.0
Mountainair	76	22	46.0	3.66	14.0
Portales	81	30	53.9	3.06	T.
Raton	73	23	45.0	2.12	4.0
Redrock	.....	.....	.....	3.04	7.0
Rociada	68	12	42.6	5.27	32.5
Rosa	.....	.....	.....	3.02	.....
Rosedale	.....	.....	.....	2.25	T.
Salado	.....	.....	.....	3.91	
San Marcial	85	32	57.6	1.28	T.
San Rafael	81	23	47.2	4.31	.....
Socorro	80	31	54.6	2.60	.....
Springer	75	23	48.3	4.95	1.1
Strauss	.....	.....	.....	1.00	T.
Taos	74	22	46.3	1.80	.....
Trampas	.....	.....	.....	1.07	.....
Tucumcari	80[e]	32[e]	54.0[e]	2.10	
Vermejo	70	8	39.9	.....	17.2
Whiteoaks	.....	.....	.....	4.97	9.0
Winsors	64	11	37.6	1.78	.....
New York.					
Adams	.....	.....	.....	2.30	6.5
Addison	80	19	41.8	1.33	5.0
Akron	.....	.....	.....	2.46	.....
Ames	76	21	45.0	2.54	4.0
Amsterdam	75	24	43.6	2.29	2.0
Appleton	76	26	42.9	1.70	T.
Arcade	72	18	40.8	2.26	3.9
Athens	78	27	48.2	2.23	T.
Atlanta	77	20	44.0	2.22	2.0
Atwater	.....	.....	.....	2.23	4.1
Auburn	76	25	44.0	3.05	T.
Avon	76	21	43.1	2.08	1.0
Baldwinsville	78	25	43.2	2.07	T.
Ballston Lake	73	22	43.9	2.33	1.2
Bedford	77	26	49.0	3.14	
Berlin	76	21	44.6	1.65	T.
Blue Mountain Lake	.....	.....	.....	3.63	9.0
Bolivar	72	14	42.0	2.65	10.2
Bouckville	74	16	39.8	2.54	12.0
Brockport	76	25	43.7	.....	
Cape Vincent	70	23	39.5	2.20	.....
Carmel	75	24	44.8	3.18	.....
Carvers Falls	75	18	41.8	2.51	.....
Chatham	77	22	46.4	2.12	1.0
Chazy	75	21	42.2	0.99	4.0
Coeymans	76	22	46.6	2.08	T.
Cold Spring Harbor	.....	.....	.....	3.25	T.
Cooperstown	72	22	41.2	3.09	4.1
Cortland	76	22	43.9	2.63	1.4
Cutchogue	60	30	47.0	3.06	T.
Deansboro	.....	.....	.....	2.55	8.0
Dekalb Junction	.....	.....	.....	1.87	1.0
De Ruyter	73	18	41.6	3.11	8.0
Elba	75	20	42.1	2.90	3.1
Elmira	82	23	47.8	1.82	4.2
Faust	74	11	37.4	2.63	5.0
Fayetteville	77	25	45.2	3.05	2.5
Fort Plain	76	27	46.4	2.37	T.
Franklinville	72	22	41.6	3.80	8.0
Gansevoort	.....	.....	.....	2.71	.....
Glens Falls	74	22	44.8	2.17	T.
Gloversville	75	23	42.6	3.01	1.0
Greenfield	73	24	43.8	2.85	.....
Greenwich	75	21	43.8	2.42	T.
Griffin Corners	72	18	41.6	1.94	4.0
Harkness	73	21	42.2	1.76	2.7
Haskinville	.....	.....	.....	2.20	3.7
Hemlock	.....	.....	.....	2.65	.....
Hunt	76	22	43.6	2.66	5.3
Indian Lake	74	14	40.2	3.13	.....
Ithaca	76	23	42.9	2.64	10.8
Jamestown	73	22	43.6	3.24	7.0
Jeffersonville	77	19	44.3	1.54	T.
Keene Valley	74	17	40.8	2.22	1.0
Lake George	73	23	43.2	2.74	T.
Le Roy	75	22	43.3	2.25	2.5
Liberty	71	19	42.4	1.76	1.4
Littlefalls, City Res.	71	20	43.2	2.72	T.
Lockport	73	25	43.2	1.78	T.
Lowville	74	21	40.0	2.86	3.5
Lyndonville	.....	.....	.....	1.64	.....
Lyons	80	22	45.2	3.23	T.
Middletown	74	27	48.2	1.98	T.
Mohonk Lake	70	24	45.3	2.28	T.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
New York—Cont'd.	°	°	°	*Ins.*	*Ins.*
Moira	76	18	42.5	2.73	8.0
Mt. Hope	76	25	48.6	2.11	T.
Newark Valley	.....	.....	.....	2.56	7.0
New Lisbon	73	18	40.8	2.72	5.0
Number Four	67	16	37.0	3.71	9.4
Ogdensburg	76	19	44.3	0.96	3.2
Oneonta	78	24	44.9	2.22	2.0
Oswegatchie	.....	.....	.....	2.87	2.0
Oxford	74	21	44.0	4.07	4.5
Oyster Bay	74	30	49.8	2.63	T.
Palermo	.....	.....	.....	3.40	1.0
Perry City	76	21	42.9	2.76	10.2
Port Jervis	79	24	48.7	1.85	T.
Potsdam	73	19	42.4	2.76	15.0
Richland	79	20	41.0	.....	
Richmondville	76	24	44.4	1.13	T.
Ridgeway	72	25	43.2	2.27	1.5
Ripley	75	26	43.9	2.30	3.0
Romulus	77	25	44.8	2.75	3.8
Salisbury Mills	.....	.....	.....	2.38	T.
Saranac	72	15	38.0	2.59	9.4
Scarsdale	75	26	48.0	2.38	T.
Setauket	70	30	47.4	3.00	T.
Shortsville	76	23	43.2	2.04	1.1
Skaneateles	.....	.....	.....	2.77	.....
Southampton	63	28	45.6	2.28	
South Canisteo	76	19	42.6	3.03	13.5
South Kortright	94	17	42.4	2.16	3.6
South Schroon	70	20	40.4	3.03	T.
Spier Falls	75	22	44.0	1.51	T.
Straits Corners	.....	.....	.....	2.85	9.0
Ticonderoga	74	23	43.6	2.42	.....
Volusia	72	22	41.8	1.40	5.0
Wappinger Falls	75	25	48.2	3.29	T.
Warwick	.....	.....	.....	2.68	T.
Watertown	74	22	41.9	2.00	3.0
Waverly	81	18	45.6	2.31	3.9
Wedgwood	73	22	42.2	2.24	8.5
Wells	76	17	41.2	3.50	2.0
West Berne	76	21	44.4	1.33	2.0
Westfield	72	26	43.2	2.31	3.0
North Carolina.					
Battleboro	.....	.....	.....	4.95	
Brevard	83	26	55.0	4.30	T.
Brewers	83	20	55.6	4.63	T.
Bryson City	.....	.....	.....	3.88	T.
Chalybeate Springs	92	27	60.4	6.78	
Catawba	.....	.....	.....	2.88	
Chapelhill	88	30	58.6	5.19	
Currituck	.....	.....	.....	2.24	
Eagletown	82	32	55.6	5.45	
Edenton	82	34	57.4	8.20	
Fayetteville	89	32	60.5	3.01	
Goldsboro	89	32	61.0	5.34	
Graham	.....	.....	.....	3.03	
Greensboro	85	30	57.4	3.90	
Henderson	88	30	58.1	5.71	T.
Hendersonville	80	23	55.6	2.02	T.
Henrietta	85	28	59.4	2.20	
Horse Cove	78	25	54.7	5.36	0.3
Hot Springs	77	31	56.8	.....	.....
Jefferson	76	24	52.3	2.79	T.
Kinston	90	29	61.2	4.06	
Lenoir	85	27	57.8	2.06	
Lexington	86	26	58.4	3.23	
Lincolnton	83	28	58.0	1.45	
Linville	74	20	47.2	3.44	3.0
Louisburg	86	30	59.0	4.03	T.
Lumberton	88	31	60.7	3.83	
Manteo	82	38	57.5	3.65	
Marion	85	27	58.6	1.95	T.
Marshall	82	27	56.0	3.21	T.
Moncure	86	28	59.4	5.07	
Monroe	85	26	59.0	4.66	
Morganton	85	29	58.2	2.12	
Mountairy	85	23	56.0	3.95	T.
Mount Holly	.....	.....	.....	3.68	
Murphy	.....	.....	.....	4.79	T.
Nashville	89	30	59.1	5.51	T.
Newbern	86	31	60.8	5.04	
Patterson*[1]	80	26	52.4	3.59	T.
Pinehurst	88	30	61.2	4.95	
Pittsboro	86	27	58.7	3.36	.....
Randleman	.....	.....	.....	3.37	
Reidsville	86[e]	29[e]	58.2[e]	4.59	
Salem	85	27	57.5	3.24	
Salisbury	87[e]	28[e]	58.4[e]	2.68	T.
Saxon	87	25	55.8	5.34	T.
Scotland Neck	85	33	59.0	6.27	T.
Selma	90[f]	30[d]	59.1[e]	4.50	
Settle	88	28	59.1	3.21	T.
Sloan	86	30	57.6	4.82	
Snowhill	89	28	59.7	4.27	
Southern Pines	88	30	62.0	6.30	
Southport	82	31	62.0	4.95	
Statesville	84	27	59.2	2.28	T.
Tarboro	88	31	59.8	7.52	
Washington	85	31	59.4	4.26	

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
North Carolina—Cont'd.	°	°	°	*Ins.*	*Ins.*
Waynesville	79	25	55.2	3.60	1.4
Weldon	88	29	58.1	3.27	T.
Whiteville	89	30	61.4	4.69	
North Dakota.					
Amenia	75	11	40.0	1.56	1.0
Ashley	73	10	39.1	1.27	T.
Berlin	74	11	38.2	1.69	0.4
Bottineau	78	9	40.0	0.47	T.
Cando	73	15	38.6	0.01	T.
Churchs Ferry	78	16	40.5	0.07	0.7
Coalharbor	74	8	41.5	0.84	1.0
Cooperstown	76	16	38.9	0.89	T.
Dickinson	83	3	43.0	0.09	0.5
Donnybrook	76	8[b]	39.6[d]	0.15	1.5
Edgeley	75	18	40.4	1.41	
Ellendale	75	11	44.0	0.85	
Fargo	77	12	39.5	1.28	......
Forman	77	17	42.6	1.97	
Fort Berthold	78	8	44.6	0.07	
Fort Yates	78	18	43.7	0.56	0.3
Fullerton	74	14	39.8	1.40	T.
Glenullin	79	10	41.2	0.14	T.
Grafton	69[f]	16[f]	37.8[f]	0.05	
Hamilton	78	15	38.4	0.41	0.4
Hannaford	77	15	41.0	0.64	0.4
Jamestown	75	21	42.9	1.28	0.6
Kulm	74	17	41.5	1.74	0.1
Langdon	75	13	37.4	0.16	
Larimore	76	15	38.6	0.59	
Lisbon	78	15	40.4	1.63	2.0
McKinney	77	7	37.6	0.10	1.0
Manfred	75	14	39.7	0.33	3.0
Mayville	76	19	40.9	1.22	
Medora	83	4	43.4	0.25	0.2
Melville	80	17	42.2	1.37	1.0
Milton	78	15	39.2	0.00	
Minnewaukon	74[f]	16[e]	40.0[d]	00.0	
Minto	73	12	38.0	0.41	
Napoleon	77	6	39.2	0.65	T.
Park River	77	17	40.6	0.26	
Pembina	80	15	37.8	0.39	0.4
Power	77	16	41.6	1.40	1.5
Rolla	75	13	38.4	0.05	0.2
Rugby	74	12	38.7	0.15	0.5
Steele	74[e]	13[e]	40.6[e]	0.18	T.
University	77	16	41.2	0.96	
Walhalla	78	12	39.8	T.	T
Washburn	77	11	42.4	0.10	
Westhope	76	7	39.6	0.21	1.2
Willow City	76	6	38.0	T.	T.
Wishek	72[g]	18[g]	41.1[g]	1.29	
Ohio.					
Akron	74	23	46.2	3.03	5.5
Amesville	85	21	51.7	3.61	2.6
Atwater	......	......	......	2.53	2.5
Bangorville	78	19	47.5	3.22	3.3
Bellefontaine	75	16	47.0	4.46	4.8
Benton Ridge	75	22	48.4	3.99	2.0
Bladensburg	79	18	46.4	2.30	0.7
Bowling Green	75	21	46.4	3.36	3.5
Bucyrus	76	18	46.4	2.10	2.0
Cadiz	80	23	49.0	2.59	3.1
Cambridge	82	20	47.5	2.14	T.
Camp Dennison	85	21	52.8	3.19	0.4
Canal Dover	79	22	47.0	2.50	1.0
Canton	75	25	47.1	3.25	3.5
Cardington	77	12	46.6	3.57	5.8
Chillicothe	84	19	51.0	2.28	3.4
Clarington	80	26	51.2	2.57	0.2
Clarksville	81	25	52.0	3.38	1.0
Cleveland *a*	75	29	45.0	2.61	4.2
Cleveland *b*	75	29	44.8	2.15	3.8
Coalton	85	19	52.6	2.76	0.6
Colebrook	73	23	43.8	2.32	4.0
Dayton	82	24	51.2	4.20	1.8
Defiance	77	19	46.6	3.29	0.5
Delaware	79	23	47.8	3.70	3.5
Demos	84	22	51.8	2.91	0.2
Findlay	78	21	48.4	3.67	0.5
Frankfort	85	22	52.3	3.46	......
Fremont	78	24	47.8	3.82	T.
Garrettsville	75	21	45.0	2.76	5.2
Granville	80	25	49.1	2.66	2.1
Gratiot	80	23	49.2	2.17	2.0
Green	82	26	52.7	2.95	T.
Greenhill	80	22	45.0	2.37	2.0
Greenville	79	24	49.8	4.73	......
Hedges	77	19	48.0	3.21	T.
Hillhouse	77	17	42.5	2.53	2.0
Hiram	74	24	45.5	2.59	4.5
Hudson	80	23	46.2	3.19	......
Ironton	87	26	55.6	2.03	......
Jacksonburg	84	26	52.0	3.63	2.1
Kenton	74	23	48.3	3.01	2.0
Killbuck	78	21	47.8	2.67	1.5
Lancaster	82	25	50.4	2.63	1.1
Lima	77	24	49.5	3.02	1.0
Manara	78	22	49.6	3.54	0.3
Ohio—Cont'd.	°	°	°	*Ins.*	*Ins.*
McConnelsville	82	24	50.2	3.03	5.0
Mansfield	......	......	......	2.95	2.5
Marietta	82	29	52.6	3.65	T.
Marion	79	21	48.8	3.26	2.1
Medina	76	22	46.0	3.81	8.0
Milfordton	80	18	46.6	3.39	3.5
Milligan	83	19	48.6	2.61	1.0
Millport	74	20	46.0	2.24	3.4
Montpelier	78	22	46.7	3.71	3.0
Napoleon	75	24	48.2	2.99	T.
Nellie	79	19	48.2	2.88	0.5
New Alexandria	77	25	48.5	2.90	T.
New Berlin	76	23	46.5	3.07	5.0
New Bremen	74	22	49.1	3.46	1.5
New Richmond	82	27	54.0	2.72	0.3
New Waterford	85	22	45.8	2.68	0.5
North Lewisburg	78	21	48.5	4.75	4.0
North Royalton	......	22	45.6[e]	3.66	6.0
Norwalk	77	22	47.1	3.37	1.0
Oberlin	76	24	45.8	3.70	7.6
Ohio State University	78	24	48.6	3.39	0.4
Orangeville	75	21	45.4	2.16	2.0
Ottawa	77	20	47.0	3.60	......
Pataskala	81	24	48.6	3.18	0.9
Philo	82	25	50.5	2.25	1.4
Plattsburg	78	23	49.6	3.83	1.0
Pomeroy	86	24	52.3	2.81	T.
Portsmouth	84	28	54.3	2.46	T.
Pulse	80	24	52.2	3.63	1.6
Rittman	75	21	46.2	1.68	T.
Rockyridge	77	22	46.2	3.46	3.0
Shenandoah	74	19	45.0	2.75	2.5
Sidney	77	25	50.3	4.53	3.7
Somerset	80	25	50.4	2.80	0.5
South Lorain	78	24	45.2	3.00	1.5
Springfield	......	......	......	3.91	0.8
Thurman	89	22	55.4	2.45	T.
Tiffin	73	26	47.3	3.55	1.5
Upper Sandusky	74	24	48.6	3.18	0.2
Urbana	78	23	48.2	4.24	2.0
Vickery	76	22	45.2	3.72	3.8
Warren	78	25	45.4	2.30	5.2
Wauseon	77	21	45.6	3.48	6.0
Waverly	85	22	53.2	3.60	2.9
Waynesville	80	23	50.4	4.18	......
Wellington	77	24	47.2	3.45	0.5
Willoughby	......	......	......	2.49	......
Wilson	84	20	52.7	3.92	T.
Wooster	77	23	46.8	2.51	2.0
Zanesville	......	......	......	2.13	0.9
Oklahoma.					
Alva	98	34	56.8	2.16	
Arapaho	91	33	57.4	5.13	
Beaver	86	28	54.0	4.97	T.
Binger	91	32	57.4	3.76	
Busch	89	33	54.0	4.29	
Chandler	91	31	59.0	5.60	
Cleo	93	29	55.0	......	
Cloud Chief	88	32	56.5	5.00	
Eldorado	88[e]	33[e]	58.6[e]	3.67	
Enid	92	33	56.4	2.35	
Erick	90	32	56.9	6.40	T.
Fort Reno	89	33	57.8	5.70	
Fort Sill	89	34	57.0	6.95	
Gage	89	29	54.6	3.05	T.
Grand	90	30	55.8	4.10	
Guthrie	89	34	58.3	4.07	
Harrington	89	28	54.2	4.47	T.
Hennessey	90	34	58.0	3.78	
Hobart	88	32	58.0	6.52	
Jefferson	95	32	57.2	2.18	
Jenkins	93	32	57.4	1.12	
Kenton	80	27	51.2	5.93	T.
Kingfisher	91	34	58.9	3.77	
Luther	91	36	62.0	3.43	
McComb	89	36	59.4	4.84	
Meeker	91	37	61.2	3.85	
Newkirk	91	32	56.8	1.69	
Norman	89	35	59.4	6.01	
Okeene	92	32	57.2	2.00	
Perry	91	33	58.0	3.26	
Shawnee	89	36	60.2	4.43	
Stillwater	91	35	57.8	2.80	
Taloga	......	......	......	3.24	
Temple	88	38	61.8	4.32	
Watonga	91	32	56.5	3.56	
Waukomis	92	33	57.9	3.23	
Weatherford	89	31	55.6	3.80	
Whiteagle	94	33	58.6	1.72	
Oregon.					
Albany	......	......	......	0.79	
Alpha	85	28	52.9	0.78	
Arlington	83	30	55.5	0.05	
Ashland	82	31	51.8	0.31	
Astoria	72	37	52.8	1.53	
Aurora (near)	83	31	53.6	1.50	
Bay City	74	31	49.8	1.77	
Bend	79	16	45.6	0.29	
Oregon—Cont'd.	°	°	°	*Ins.*	*Ins.*
Beulah	76	19	41.8	0.46	
Blackbutte	79	30	50.2	1.10	
Blalock	89	34	58.6	0.17	
Bonita	78	31	50.7	2.05	
Bullrun	......	......	......	3.19	
Burns	74	25	46.3	0.65	
Butter Creek	......	......	......	0.28	
Cascade Locks	84	32	55.2	1.49	
Coquille	......	......	......	1.19	
Corvallis	85	31	53.2	0.67	
Dayville	80	26	51.6	1.02	
Doraville	83	31	51.1	1.57	
Drain	85	26	53.8	0.93	
Ella	......	......	......	0.21	
Eugene	79	32	53.3	0.96	
Fairview	80	28	52.6	0.91	
Falls City	80	31	51.2	0.86	
Forestgrove	83	29	......	1.49	
Gardiner	72	34	52.1	2.38	
Glendale	83	28	52.1	0.79	
Glenora	84	28	50.4	1.93	
Gold Beach	68	34	52.0	2.09	
Government Camp	73	25	41.2	1.62	7.0
Grants Pass	87	28	54.2	0.45	
Grass Valley	80	20	46.8	0.03	
Heisler	81	22	49.8	......	
Hood River	88	30	54.7	0.41	
Huntington	80	26	52.9	0.10	
Jacksonville	84	32	54.3	0.67	
John Day	80	25	48.7	1.63	
Joseph	70	18	44.6	1.98	4.0
Kerby	83	27	52.8	1.59	
Klamath Falls	73	25	48.6	0.65	
Lagrande	75	25	48.2	1.52	
Lakeview	75	24	46.2	0.44	
Lonerock	78	23	46.6	0.63	T.
McKenzie Bridge	85	23	51.6	1.91	
McMinnville	83	31	53.2	1.59	
Marshfield	79	31	53.0	1.88	
Meacham	......	......	......	1.90	T.
Mill City	78	26	50.8	[illegible]	
Monroe	81	31	[illegible]	[illegible]	
Mount Angel	85	35	55.4	1.58	
Nehalem	......	......	......	1.84	
Newport	75	35	51.5	1.44	
Ontario	......	......	......	2.40	
Paisley	71	26	48.2	......	
Pendleton	82	26	51.8	0.50	
Port Oxford	65	40	51.2	2.82	
Prineville	77	20	46.8	0.32	
Riverside	81	16	47.3	0.42	
Salem	80	35	54.4	0.86	
Silverlake	75	14	43.1	0.70	0.3
Sparta	72	24	46.8	1.69	T.
Stafford	83	34	53.7	1.99	
The Dalles	85	30	55.2	0.18	
Toledo	76	29	51.2	0.95	
Umatilla	90	31	57.5	0.30	
Vale	78	24	50.9	0.66	
Wallowa	76	21	47.0	1.43	T.
Wamic	83	24	49.4	0.63	
Warm Spring	84	22	51.0	0.42	
Weston	79	23	47.2	2.21	T.
Williams	70	26	51.2	0.23	
Pennsylvania.					
Aleppo	84	22	49.4	2.91	1.0
Altoona	73	23	47.8	1.98	......
Beaver Dam	......	......	......	3.22	4.5
Bellefonte	78	24	51.0	2.50	T.
Brookville	......	......	......	2.60	2.0
Browers	......	......	......	4.28	T.
California	80	24	50.6	3.68	T.
Cassandra	71	20	45.2	2.74	13.5
Centerhall	76	18	48.6	2.81	3.0
Clarion	......	......	......	2.72	
Claysville	79	24	49.8	3.46	2.0
Clearfield	......	......	......	2.44	2.5
Coatsville	80	24	50.8	3.38	T.
Confluence	......	......	......	3.59	2.0
Coudersport	73	17	43.1	2.38	7.0
Davis Island Dam	......	......	......	2.66	
Derry	76	25	48.0	3.28	4.5
Doylestown	......	......	......	4.15	
East Mauch Chunk	80	22	49.1	2.68	T.
Easton	76	25	50.2	1.90	T.
Ellwood Junction	......	......	......	2.96	
Emporium	75	20	46.2	2.64	1.7
Ephrata	77	24	49.8	3.11	T.
Everett	76	20	49.0	1.47	4.0
Forks of Neshaminy	......	......	......	3.64	
Franklin	77	19	45.8	2.02	1.0
Freeport	......	......	......	3.12	T.
Gettysburg	77	25	51.6	2.95	0.5
Girardville	......	......	......	2.71	4.5
Gordon	74	17	48.0	2.42	1.0
Grampian	72	20	44.6	3.22	9.0
Greensboro	......	......	......	3.99	5.0
Greenville	75	23	45.8	3.56	3.0

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Pennsylvania—Cont'd.	°	°	°	*Ins.*	*Ins.*
Hamburg	83	24	50.2	3.88	
Hanover	77	28	52.4	2.70	T.
Herrs Island Dam				2.52	
Huntingdon	78	21	49.4	1.79	1.0
Indiana	76	24	47.4	4.74	11.2
Irwin	80	25	50.2	3.44	1.3
Johnstown				3.63	T.
Kennett Square	79	25	50.8	3.94	T.
Lansdale				3.89	
Lawrenceville[a]	78	16	43.3		6.0
Lebanon	76	24	50.7	2.46	0.9
Leroy	76	20	44.8	2.38	7.3
Lewisburg	78	23	50.2	1.64	T.
Lockhaven	80	23	50.6	2.32	0.5
Lock No. 4				2.88	
Lycippus	76	25	48.8	3.89	10.3
Marion	76	27	50.2	1.83	
Mifflin				1.63	
Mifflintown	77	21	49.8	2.09	T.
Milford	79	20	46.9	1.88	T.
Montrose	78	19	44.0	2.01	
New Germantown	75	24	50.0	2.05	0.5
Ottsville				2.99	
Parker				2.48	T.
Philadelphia	80	33	53.0	3.89	1.0
Pocono Lake	72	17	43.2	1.51	
Point Pleasant				3.23	
Pottsville				2.14	
Quakertown	77	23	50.4	2.31	T.
Reading	77	26	51.8	2.85	T.
Saegerstown	76	17	45.2	3.07	8.1
St. Marys	72	22	44.5	3.75	
Saltsburg				4.34	3.2
Seisholtzville				2.19	
Selinsgrove	76	22	49.4	2.10	7.0
Shawmont				2.70	
Skidmore	75	22	46.2	2.33	1.5
Smiths Corners				3.07	
Somerset	75	20	44.8	4.46	13.8
South Eaton	74	25	47.9	1.85	T.
Springdale				3.32	
Springmount				2.55	
State College	74	18	45.6	2.49	0.9
Swarthmore	78[j]	25[h]	52.8[j]	2.90	
Towanda	77	22	45.6	2.30	6.1
Uniontown	80	26	50.2	2.84	5.5
Warren	76	18	44.4	4.09	7.8
Wellsboro	75	22	43.8		4.5
Westchester	79	27	51.0	3.86	T.
West Newton				3.44	2.0
Wilkesbarre	78	26	48.8	2.03	T.
Williamsport	75	25	50.0	1.65	0.5
Rhode Island.					
Bristol	62	31	45.6	2.55	
Kingston	70	23	44.6	2.83	T.
Narragansett	64	26	44.2	2.43	T.
Pawtucket	76	34	50.2	4.20	
Providence *a*	72	32	49.0	3.24	T.
South Carolina.					
Aiken	90	28	63.7	3.20	
Allendale	90	35	62.0	3.28	
Anderson	87	30	62.8	3.91	T.
Barksdale	82	28	62.0	2.00	
Batesburg	86	31	63.4	5.02	T.
Beaufort	86	39	66.4	2.60	
Bennettsville				2.79	
Blackville	89	29	65.2	4.01	
Bowman	90	30	64.8	4.59	
Calhoun Falls				1.90	
Camden				3.79	
Cheraw	87	32	61.2	4.44	
Clarks Hill	89	30	64.0	2.16	
Clemson College	83	30	62.0	2.79	
Conway	90	34	62.6	7.00	
Darlington	88	31	62.3	6.08	
Dillon	90	30	62.2	4.78	
Due West	82	31	62.6	4.05	
Edisto				2.92	
Effingham				7.20	
Enoree				2.23	
Florence	88	34	62.4	4.26	
Gaffney	87	30	61.5	2.10	
Georgetown	85	36	64.2	5.09	
Greenwood	85	31	61.8	2.93	
Heath Springs	83	28	59.7	4.23	
Kingstree	88	28	62.4	3.11	
Liberty	86	31	62.8	3.72	
Little Mountain	83	31	63.6	3.99	
Newberry	86	29	62.0	3.93	T.
Pelzer				2.74	
Pinopolis *[1]	84	35	61.8	3.25	
St. George	89	34	63.9		
St. Matthews	85	35	62.4	3.41	
St. Stephens				2.30	
Saluda	87	27	63.4	3.98	T.
Santuck	84	32	61.8	3.29	
Seivern	89	28	62.0	5.32	T.
Smiths Mills				4.38	

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
South Carolina—Cont'd.	°	°	°	*Ins.*	*Ins.*
Society Hill	87	35	61.4	4.21	
Statesburg	85	32	64.2	4.22	
Summerville	88	33	64.1	3.95	
Trenton	87	31	63.0	4.20	
Trial	88	30	64.0	3.8[a]	
Walhalla	85	28	60.4	2.92	
Walterboro	92	33	66.8	3.75	
Winnsboro	83	32	62.6	7.03	
Winthrop College	83	30	61.7	2.83	
Yemassee	90	33	65.5	3.75	
Yorkville	86	31	63.1	2.53	
South Dakota.					
Aberdeen	75	18	44.0	1.55	
Academy	76	20	46.4	1.19	1.2
Alexandria	75	19	46.6	0.78	1.0
Armour	80	16	47.0	1.20	1.5
Ashcroft	82	12	43.7	0.90	7.0
Bowdle	74[c]	17[c]	43.4[c]	1.75	4.0
Brookings	73	14	42.3	1.01	2.0
Canton	77	8	45.6	0.67	3.0
Centerville	76	13	46.0	0.92	2.6
Chamberlain	79	19	47.1	1.35	2.0
Cheyenne	78	12	45.6	1.70	2.0
Clark	72	15	43.4	0.85	3.0
Clear Lake	86	19	42.8	1.02	
Doland	73	13	43.5	0.92	2.0
Elkpoint	80	15	47.2	2.34	1.0
Fairfax	78	19	44.6	1.35	2.5
Farmingdale				1.32	2.0
Faulkton	74	12	43.9	1.72	0.5
Flandreau	78	15	43.9	0.88	2.2
Forestburg	80	12	45.3	2.16	T.
Gannvalley	78	20	46.2	1.26	3.0
Grand River School	80	16	44.2	0.82	5.0
Greenwood	81	19	47.6	1.80	1.0
Highmore	73	17	44.4	1.39	2.0
Hitchcock				1.13	
Hotch City	77	16	44.6	1.12	4.0
Howard	75	15	45.8	0.93	1.0
Howell	76	11	42.9	0.86	2.1
Ipswich	78	15	42.0	1.93	3.0
Kidder	73	14	41.4	1.50	T.
Kimball	87	18	46.9	0.68	
Leola	73	11	42.4	2.10	1.0
Leslie	80	15	47.3	1.10	2.0
Marion	77[d]	12[d]	45.7[d]	0.78	3.0
Mellette	77	13	43.4		
Menno	78	11	45.7	1.02	0.8
Milbank	74	10	42.2	1.25	
Mitchell	77	18	46.8	0.92	2.0
Oelrichs	86	15	43.1	2.20	
On-the-Trees Camp	78	16	44.4	1.63	2.0
Pine Ridge	80	11	43.2	1.72	4.0
Plankinton	76	16	45.8	1.18	
Ramsey	78	11	44.4	1.40	4.0
Redfield	75	15	43.2	0.53	3.0
Sioux Falls	78	14	46.5	0.73	
Sisseton Agency	73	15	42.4	1.26	
Spearfish	72	15	44.0	1.05	3.0
Stephan	75	15	44.2	0.68	2.0
Tyndall	80	16	46.8	1.93	
Vermillion	80	16	48.2	1.30	0.2
Watertown	70	17	42.5	1.46	0.5
Wentworth	77	17	44.6	0.58	0.5
Wolsey				0.84	3.5
Tennessee.					
Andersonville				2.25	
Arlington	85	31	59.8	3.82	
Ashwood	86	24	59.0	2.35	
Benton	85	25	60.0	5.52	
Bluff City				3.30	
Bolivar	87	28	59.8	3.03	
Bristol	82	27	56.6	3.07	T.
Brownsville	85	32	59.9	5.33	
Byrdstown	84	26	57.4	2.51	1.1
Carthage	85	32	60.3	3.04	
Catlettsburg				4.83	
Cedar Hill	85	30	58.5	1.60	T.
Celina				2.30	T.
Charleston				4.00	
Clarksville	87	30	58.6	2.14	T.
Clinton				4.06	T.
Covington	86	31	60.2	3.76	
Dandridge				3.98	T.
Decatur	87	22	58.6	4.37	T.
Dickson	88[c]	22[c]	58.4[c]	2.54	
Dover	90	24	59.6	2.46	T.
Dyersburg	85	31	58.8	3.50	
Elizabethton	80	28	55.5	3.39	T.
Erasmus	83	18	53.8	3.07	T.
Florence	83	25	58.5	3.55	T.
Franklin	85	26	58.6	2.74	T.
Grace				1.60	
Greeneville	81	29	57.0	3.88	1.0
Halls Hill				3.37	
Harriman	85	29	57.4	3.29	T.
Hohenwald	88	18	57.1	2.25	0.2
Iron City	88	25	60.1	3.31	

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Tennessee—Cont'd.	°	°	°	*Ins.*	*Ins.*
Isabella	83	30	57.8	4.54	T.
Johnsonville	91	25	60.0	2.55	
Jonesboro				2.63	T.
Kenton	85	27	59.4	4.56	T.
Kingston				3.08	T.
Lafayette	86	28	58.6	1.86	T.
Leadvale				4.60	T.
Lewisburg	87	26	60.6	3.04	T.
Liberty	87[c]	23[c]	59.8[c]	3.59	T.
Loudon				3.50	
Lynnville	83	25	59.8	2.75	T.
McGee				4.20	
McMinnville	86	26	59.1	2.66	0.9
Maryville	86	28	58.6	5.47	T.
Milan	86	29	59.8	4.59	
Newport	86	32	58.0	4.34	T.
Palmetto	84	26	60.2	2.69	T.
Pope	90	22	61.4	2.00	
Rogersville	85	28	56.6	2.90	T.
Rotherwood				3.40	
Rugby	85	20	54.6	2.59	T.
Savannah	86	28	61.9	2.99	T.
Sewanee	81	27	56.8	3.72	T.
Silver Lake	77	19	51.5	3.80	T.
Springdale	88	25	55.5	3.45	T.
Springville	89	25	59.5	2.28	T.
Tazewell				3.92	T.
Tellico Plains	86	25	61.2	5.28	T.
Tracy City	81	22	56.0	4.35	T.
Trenton	87	28	59.5	4.27	
Tullahoma	85	24	58.8	4.34	1.5
Union City	87	26	58.0	3.28	
Walling				3.30	
Waynesboro	87	25	61.0	2.69	T.
Wildersville	84	29	60.6	3.08	
Yukon	83	29	59.4	3.93	
Texas.					
Albany	92	33	61.8	5.65	
Alvin				7.75	
Anson				3.96	
Arthur				6.39	
Athens	88	42	64.2	9.25	
Austin	89	43	68.2	8.05	
Ballinger	90	34	61.0	3.51	
Beaumont	91	40	70.2	7.55	
Beeville	91	45	69.9	5.43	
Bigspring	88	32[c]	60.0[d]	3.34	
Blanco	87	38	62.8	9.75	
Boerne	87	38	65.6	9.30	
Booth				9.69	
Bowie	91	33	62.4	5.28	
Brazoria	84	45	69.9	11.64	
Brenham	85	45	67.3	9.78	
Brighton	84	46	71.6	1.96	
Brownwood	92	38	65.4	5.42	
Channing	82	28	53.2	5.52	
Childress	89	33	59.3	3.29	
Clarenden	88	22	54.9	8.16	
Clarksville	88	39	62.4	6.77	
Claude	83	29	52.9	5.26	
Claytonville	90	35	60.6	3.76	
Coleman	89	36	62.6	4.05	
College Station	85	44	69.5	6.31	
Colorado	90	31	62.5	2.72	
Columbia	84	45	70.0	8.60	
Columbus				6.75	
Comanche	91	34	62.7	5.89	
Comstock	86	38	62.3	7.98	
Corsicana	91	39	63.6	6.90	
Cotulla	95	50	69.4	3.91	
Crockett	84	42	66.0	7.87	
Cuero	89	45	70.9	7.69	
Dallas	89	39	62.6	7.11	
Danevang	87	42	70.4	8.12	
Decatur	85	35	60.2	5.50	
Dialville	85	41	65.0	9.89	
Dublin	86	42	58.4	8.40	
Duval	86	41	66.4	6.65	
Eagle Pass	95	42	69.2	5.59	
Fort Brown	96	54	76.0	1.98	
Fort Clark	87	40	67.4	3.85	
Fort Davis	80	29	56.4	0.94	
Fort McIntosh	96	47	73.2	7.35	
Fort Ringgold	100	50	78.1	0.11	
Fort Stockton	89	31	60.8	0.42	
Fredericksburg	86[c]	32[c]	63.7[c]	9.48	
Gainesville	86	38	61.4	4.69	
Gatesville	89	38	67.0	5.80	
Georgetown	89	38	66.0	7.81	
Gonzales				3.88	
Graham	96	32	63.4	4.15	
Grapevine	90	34	59.6	6.93	
Greenville	87	39	63.4	7.99	
Hale Center	85	34	56.8	3.49	
Hallettsville	87	46	69.8	12.76	
Haskell	92	31	61.6	2.63	
Hearne	86	42	66.7	8.78	
Hebbronville	99	44	73.2	3.06	

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Texas—Cont'd.	°	°	°	Ins.	Ins.
Hempstead				9.32	
Henrietta	90	36	60.3	3.56	
Hereford	84	29	53.8	3.70	
Hewitt				11.28	
Hillsboro	89	37	64.9	8.15	
Hondo	86	41	66.4	6.67	
Houston	89	46	69.7	7.44	
Huntsville	88	43	67.8	8.73	
Jefferson	87	39	65.4	7.92	
Jewett	85	41	66.2	9.09	
Junction				3.72	
Kaufman	85	42	65.7	5.50	
Kent	86	36	62.2	0.80	
Kerrville	87	38	63.0	9.16	
Knickerbocker	87	27	62.3	3.07	
Kopperl				10.10	
Lampasas	90	36	63.8	7.47	
Lapara				1.70	
Liberty	87	50	67.1	4.60	
Llano				8.50	
Lone Star Ranch	85	29	54.0	5.02	1.0
Longlake				8.81	
Longview	78	43	57.4	8.00	
Luling	86	43	68.5	4.78	
McKinney	88	36	63.0	7.69	
Mann [1]	89	40	66.2		
Marlin	90	40	65.2	8.88	
Menardville	88	26	60.6	4.33	
Mexia	88	40	64.0	7.55	
Mobeetie	92	32	55.8	5.20	0.8
Mount Blanco	86	34	56.0	4.13	
Mount Pleasant	86	40	64.1	9.24	
Nacogdoches	86	41	65.2	8.88	
Orange				7.90	
Panter				7.45	
Paris	85	35	60.8	2.70	
Pearsall	90	43	70.0	5.36	
Pierce	84	45	68.3	7.20	
Port Lavaca	84	47	69.6	8.48	
Quanah	93	34	65.4	3.50	
Rhineland	95	30	60.6	4.25	
Riverside				4.76	
Rockisland	85	44	68.4	7.22	
Rockland				9.08	
Rockport	82	52	67.8	3.25	
Sabinal	86	41	67.5	6.75	
San Marcos				9.54	
San Saba	90	31	64.5	4.55	
Santa Gertrude				2.61	
Sherman	85	41	63.0	5.62	
Sonora	84	31	61.8	4.62	
Sugarland	78	40	66.1	11.67	
Sulphur Springs	84	39	64.0	6.36	
Temple	89	38	64.4	7.32	
Texline	87	27	50.8	5.94	T.
Trinity	87	41	67.6	8.45	
Tulia	85[1]	28[1]	56.2[1]	7.60	
Tyler	90	42	64.8	8.72	
Uvalde				5.67	
Valley Junction				8.81	
Victoria	86[d]	49[d]	70.6[d]	7.58	
Waco	92	42	66.6	13.01	
Waxahachie	90	39	63.0	8.84	
Weatherford	89	39	62.2	5.18	
Wichita Falls				4.12	
Willspoint	86	38	64.2	10.06	
Utah.					
Alpine				3.98	
Alta				3.19	35.0
Aneth	81	28	53.0	1.50	
Beaver	74	14	45.6	1.13	
Blackrock	79	20	49.0	1.28	4.0
Blacksmith Forks				2.22	3.2
Castle Rock				2.16	4.0
Cisco	80	28	52.7	0.85	
Clear Creek				1.22	12.0
Corinne	78	23	51.4	1.62	
Coyoto	61	14	38.5	0.88	
Deseret	80	16	50.3	1.36	
Emery	63	20	41.0	0.39	0.4
Experiment Farm	85	33	59.1		
Farmington	74	20	49.5	2.08	T.
Fillmore	83	23	51.2	1.53	
Fort Duchesne	79	21	48.0	0.69	
Frisco	76	22	49.0	0.58	
Garrison	78	21	50.6	0.99	
Giles	83	24	53.8	0.78	
Government Creek	72	9	47.8	1.87	2.0
Grayson	88	25	49.8	2.87	4.0
Green River	85	12	55.6	1.00	
Heber	72[e]	16[e]	46.2[e]	2.06	
Henefer	71	16	45.4	2.45	
Hite	86	35	59.5	0.98	
Huntsville				2.51	1.0
Ibapah	75	17	45.6	0.50	
Indianola				0.94	
Kanab	72[e]	19[e]	45.8[e]	1.49	
Kelton	70	14	47.2		

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Utah—Cont'd.	°	°	°	Ins.	Ins.
La Sal	70	22	44.1	1.83	T.
Levan	72	22	47.4	1.03	T.
Loa	73	14	43.2	0.30	
Logan	79	23	51.5	1.60	
Lucin	74	20	49.2	0.55	
Manti	73[e]	20[e]	45.4[e]	1.54	
Marion				3.05	18.2
Marysvale	73	17	46.2	1.23	3.6
Meadowville	66	15	42.8	2.10	2.0
Millville				2.13	
Minersville	82	30	54.5	0.85	
Moab	86	29	55.8	0.66	
Morgan	72	19	45.8	1.38	1.5
Mount Nebo	76	21	50.9	1.02	2.0
Mount Pleasant	75	20	47.4	1.47	
Nephi				1.72	
Oak City	79[e]	32[j]	52.2[e]	1.30	
Ogden	78	23	51.4	2.45	
Parowan	76	22	47.6	0.66	4.0
Payson				1.58	
Pinto	69	19	43.6	1.48	3.0
Plateau	68	18	42.4	1.50	5.6
Provo	80	24	51.4	2.07	4.5
Ranch	70	22	43.2	2.07	
Randolph				2.22	3.0
Rockville	84	30	60.4	1.23	
St. George	85	36	59.7	0.34	
Salina				0.54	
Salt Air	72	30	52.8	1.38	
Scipio	86	17	50.6	2.00	T.
Snowville	72	19	45.7	2.04	
Soldier Summit	65	14	39.2	0.81	
Sunnyside				1.01	1.5
Thistle	79	16	47.4	2.00	
Tooele	75	22	49.8	1.88	
Torrey	74	24	43.6	0.95	
Tropic	72	25	46.6	0.70	7.0
Trout Creek	79	17	49.0	0.25	
Vernal	77	20	47.4	1.22	4.0
Woodruff	70	16	41.5	1.56	
Vermont.					
Burlington	71	22	43.7	2.15	1.0
Cavendish	77	21	42.4	1.40	T.
Chelsea	65	16	37.6	2.14	6.0
Chittenden				2.69	
Cornwall	74	25	44.6	2.67	T.
Enosburg Falls	74	19	40.3	2.22	2.5
Jacksonville	76	19	43.4	1.67	2.0
Manchester	70	22	42.8	2.22	T.
Norwich	72	19	40.2	1.62	T.
St. Johnsbury	71	17	40.8	2.22	4.0
Wells	68	18	40.2	2.51	
Westfield				2.25	9.0
Woodstock	70	20	39.7	1.63	
Virginia.					
Arvonia	87	25	56.3	2.97	T.
Ashland	85	28	56.0	2.87	T.
Barboursville	84	29	56.5	2.04	T.
Bedford		25		2.00	T.
Bigstone Gap	81	28	55.6	2.99	T.
Blacksburg	81	27	52.6	1.59	1.0
Buchanan				2.71	
Burkes Garden	73	19	48.0	2.37	3.0
Callaville	85	30	56.2	3.15	
Cape Henry	87	36	55.4	3.58	T.
Charlottesville	88	32	57.6	2.06	T.
Clarksville				4.96	
Columbia	83	28	56.2	2.88	T.
Dale Enterprise	85	24	51.8	1.72	1.0
Danville				4.27	T.
Dinwiddie	87	24	56.0	3.36	T.
Elk Knob	78	26	54.5	2.81	T.
Farmville	87	32	57.6	2.34	T.
Fredericksburg	86	25	55.4	2.30	T.
Grahams Forge	82	22	54.0	2.21	T.
Greenwich				1.19	T.
Hampton	81	36	57.0	5.76	T.
Hot Springs	80	22	50.4	1.66	T.
Howardsville				2.63	
Ivanhoe				2.10	T.
Lexington	87	26	54.8	1.46	0.3
Lincoln	84	21	52.6	2.99	T.
Marion	77	24	53.0	1.91	T.
Mendota				3.32	
Newport News	81	57	57.2	4.83	T.
Petersburg	87	32	58.4	3.38	
Quantico	88	25	56.1	2.19	T.
Radford				1.16	
Randolph				3.72	
Riverton				2.19	
Roanoke	88	28	57.8	2.09	T.
Rockymount	86	25	56.3	2.63	T.
Saxe	86	26	57.8	3.79	T.
Shenandoah				2.13	T.
Speers Ferry				3.52	T.
Spottsville	87	28	56.2	5.42	T.
Stanardsville	85	24	54.8	1.48	
Staunton	89	28	53.8	2.40	T.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Virginia—Cont'd.	°	°	°	Ins.	Ins.
Stephens City	86	25	54.2	1.92	T.
Warsaw	87	25	55.6	2.16	0.5
Wilkerson	85	28	55.8	2.79	
Williamsburg	82	28	55.2	3.71	
Woodstock	87	26	55.2	1.75	T.
Washington.					
Aberdeen	88	29	49.2	1.90	
Anacortes	68	33	49.8	0.57	
Ashford				1.76	T.
Bellingham	75	29	49.4	1.21	
Blaine	72	30	49.0	1.22	
Bremerton	79	34	51.2	1.54	
Brinnon	80	33	50.8	0.90	
Cedonia	74	25	46.4	1.57	
Centralia	89	30	51.1	1.45	
Cheney	80	24	49.2	1.38	
Clearbrook	88	26	50.4	0.98	
Clearwater	80	29	49.3	3.05	
Cle Elum	80	20	46.5	0.39	T.
Colfax	80	21	48.6	1.01	
Colville	83	21	48.6	0.53	
Conconully	79	25	48.6	0.64	
Coupeville	79	34	51.7	0.55	
Crescent	78	24	47.8	1.61	
Cusick	80	20	46.6	1.20	
Danville	83	24	48.9	0.76	
Dayton	80	27	52.2	1.34	
East Sound				0.72	
Ellensburg	84	21	49.2	0.16	
Ephrata	84	29	54.0	T.	
Grandmound	84	24[g]	50.0[d]	1.00	
Granite Falls				2.41	
Hatton	99[e]	23	56.4	0.27	
Horse Heaven				T.	
Ilwaco	73	34	51.4	2.16	
Kennewick	89	25	55.4	0.04	
Kiona	88	24	55.3	0.02	
Lacenter	83	30	52.0	1.35	
Lakeside	82	34	52.2	0.17	
Lester	84	30	48.4	1.90	1.0
Lind	83	28	51.6	0.92	
Loomis	80	31	52.5	0.77	
Mottinger Ranch	90	34	57.8	0.24	
Mount Pleasant	81	33	55.1	1.62	
Moxee	85	21	51.2	0.16	
Northport	80	18	47.2	1.06	T.
Odessa	86	21	51.0	0.32	
Olga	73	33	52.4	0.58	
Olympia	86	28	51.2	0.71	
Pinehill	86	29	53.2	0.23	
Pomeroy	79	26	50.9	1.16	
Port Townsend	72	37	50.2	0.56	
Pullman	80[e]	27	49.4[e]	1.62	T.
Republic	79	19	45.6	0.74	
Ritzville				0.41	
Rosalia	77	26	48.1	1.25	
Sedro	82	31	51.4	1.40	
Silvana	81[g]	28[f]	50.2[e]		
Snohomish	83	30	50.6	1.22	
Snoqualmie	86	29	49.4	2.31	
Southbend	76	34	54.5	T.	
South Ellensburg	86	22	48.7	T.	
Sprague				1.50	
Sunnyside	83	26	51.8	0.60	
Touchet	88	25	55.6	0.48	
Twisp	81	26	50.2	0.17	
Union	89	29	50.5	0.90	
Vancouver	85	32	54.6	1.54	
Vashon	78	35	51.2	0.97	
Wahluke	88	27	55.2	T.	
Waterville	79	26	47.9	0.17	
Wenatchee (near)	83	29	49.9	0.34	
Wilbur	80	21	47.2	1.22	
Zindel	84	31	54.2[d]	2.14	
West Virginia.					
Bancroft				2.94	T.
Bayard	77	14	46.8	3.02	11.0
Bens Run	82	27	52.4	3.71	1.0
Berkley Springs	82	22	52.4	2.16	T.
Bluefield	78	26	56.4	0.81	3.0
Buckhannon	80	24	50.8	3.54	
Burlington	85	19	50.8	1.83	1.0
Central	84	22	51.2	2.63	T.
Chapel	72	22	50.1	1.61	3.0
Charleston	86	30	56.6	3.33	T.
Creston	83	22	52.3	2.06	
Cuba	85	22	52.5	3.44	T.
Elkhorn	80	26	54.5	3.04	1.3
Fairmont	83	22[h]	52.8[d]	2.80	T.
Glenville	87	24	54.3	3.33	2.0
Grafton	83	27	51.8	4.13	1.5
Green Sulphur Springs	83	20	51.5	1.51	
Harpers Ferry				1.49	T.
Hinton				2.17	1.0
Huntington	86	25	54.7	2.84	T.
Leonard	74	23	48.1	1.61	1.1
Lewisburg	81	25	52.0	2.11	1.3
Logan	89	29	59.0	4.21	3.0

TABLE II.—*Climatological record of cooperative observers. Late reports for March*—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
West Virginia—Cont'd.	°	°	°	*Ins.*	*Ins.*
Lost Creek	83	21	49.4	3.10	0.5
Mannington	81	23	52.8	3.01	T.
Marlinton	79	22	48.8	2.05	1.0
Martinsburg	80	25	51.8	1.52	T.
Moorefield	86	21	53.8	1.10	T.
Morgantown	80	26	51.0	3.38	2.0
Moundsville	80	24	51.4	1.97	T.
New Cumberland	78	26	48.4	2.38	T.
New Martinsville	82	26	52.2	3.76	T.
Nuttallburg	82	25	52.6	1.35	T.
Philippi	87	23	51.5	3.54	2.3
Pickens	75	17	46.5	5.57	13.0
Princeton	78	28	53.4	4.05	7.0
Romney	85	21	48.8	1.35	1.3
Rowlesburg	......	......	......	3.63	
Ryan	85	22	52.7	3.57	3.2
Smithfield	83[1]	23[1]	47.2[1]	3.72	0.6
Southside	87	24	53.4	3.39	T.
Sutton	89	28	57.0	......	......
Uppertract	84	25	52.2	1.25	2.0
Wellsburg	77	26	48.0	1.86	2.5
Weston	86	24	54.6	4.29	......
Wheeling	84	33	55.2	2.48	
Williamson	89	27	56.0	2.53	......
Wisconsin.					
Amherst	74	10	43.3	1.31	0.5
Antigo	68	17	41.2	0.80	0.5
Appleton	70	23	44.6	1.31	1.1
Appleton Marsh	73	16	43.2	1.35	2.5
Ashland	......	......	......	1.98	T.
Barron	66	20	41.9	1.00	2.0
Beloit	76	28	46.6	1.35	1.1
Berlin	73	24	45.4	0.51	2.9
Black River Falls	......	......	......	0.70	
Burnett	72	26	44.6	1.07	3.9
Butternut	74	18	39.2	0.33	2.8
Chilton	71	22	45.0	1.69	3.5
Chippewa Falls	......	......	......	0.51	......
Citypoint	75	......	......	0.77	0.5
Darlington	77	19	45.8	2.08	0.5
Downing	73	18	42.4	T.	T.
Eau Claire	75	23	45.6	0.51	T.
Florence	72	18	38.0	0.81	2.3
Fond du Lac	73	22	44.6	1.72	1.0
Grand Rapids	72	17	44.1	1.09	2.0
Grand River Locks	......	......	......	1.12	1.0
Grantsburg	74	12	41.5	1.40	......
Hancock	71	20	43.8	1.18	2.0
Harvey	76	25	43.7	2.40	2.1
Hayward	74	15	39.1	2.14	0.2
Hillsboro	72	19	43.2	1.77	6.0
Koepenick	72	10	39.8	1.15	11.0
Lancaster	73	22	46.0	1.96	0.5
Manitowoc	71	25	42.5	1.07	1.0
Mauston	72	21	45.4	1.07	1.0
Meadow Valley	74	15	42.6	0.89	......
Medford	75	17	42.6	1.20	......
Menasha	......	......	......	0.95	T.
Minocqua	73	18	39.9	1.50	2.0
Mount Horeb	75	22	45.4	1.81	2.5
Neillsville	76	20	43.1	1.01	......
New London	72	22	44.8	1.21	1.0
Oconto	69	20	42.4	2.04	2.5
Osceola	74	13	42.6	0.62	T.
Oshkosh	71	22	45.2	2.11	3.0
Pine River	73	20	44.4	0.99	3.6
Portage	73	25	46.6	1.27	3.0
Port Washington	74	20	40.0	1.90	4.0
Prairie du Chien	75	25	49.4	1.55	1.2
Prentice	80	18	43.1	0.85	0.7
Racine	78	26	43.8	4.05	......
Sheboygan	70	24	43.8	2.08	6.0
Spooner	77	13	40.6	1.06	1.0
Stanley	72	21	42.7	0.91	2.7
Stevens Point	75[b]	19[e]	44.0[e]	1.41	4.4
Valley Junction	76	17	44.0	0.89	0.5
Viroqua	72	19	45.6	1.24	4.0
Watertown	73	24	45.4	2.27	5.0
Waukesha	76	25	44.2	1.49	2.0
Waupaca	72	20	43.8	1.39	2.0
Wausau	71	20	43.2	1.62	T.
Whitehall	74	17	42.8	0.80	......
Wyoming.					
Afton	65	12	42.4	2.32	5.0
Alcova	77	9	42.4	1.51	8.5
Basin	83	17	48.4	0.59	......
Bedford	63	3	38.4	2.74	6.4
Border	66	11	40.4	1.52	......
Buffalo	76	11	40.0	1.09	3.9
Cambria	74	18	40.8	0.83	4.0
Centennial	......	......	......	5.92	56.0
Chugwater	75	7	38.4	4.96	22.5
Daniel	59	2	34.9	1.14	10.5
Eatons Ranch	76	12	43.0	2.40	......
Embar	73	10	39.6	0.40	4.0
Evanston	65	15	39.8	1.71	5.0
Fayette	70	10	38.2	......	......
Fontenelle	62	14	39.2	0.55	5.5
Wyoming—Cont'd.	°	°	°	*Ins.*	*Ins.*
Fort Laramie	80	13	43.1	4.91	......
Fort Washakie	72	12	43.6	1.65	8.6
Gillette	76	17	43.6	1.87	......
Granite Canyon	66	6	35.0	4.73	48.0
Green River	75	12	43.6	1.20	......
Griggs	75	12	42.2	1.91	14.3
Hyattville	77	15	45.6	......	......
Iron Mountain	72	5	37.5	6.08	23.0
Jackson	60	4	38.5	1.45	3.0
Kirtley	76	6	38.4	2.46	10.2
Laramie	67	0	35.6	1.21	12.8
Leo	69	0	37.1	1.38	8.5
Little Medicine	63	10	34.6	1.50	15.0
Lolabama Ranch	62	— 2	34.0	2.14	16.0
Lusk	74	10	37.6	0.77	4.2
Marquette	71	14	40.4	1.67	12.0
Meeteetse	68[j]	13[j]	37.7[j]	0.90	9.0
Moore	74	10	38.8	5.77	41.8
Moorcroft	70	20	40.6	1.30	9.0
Phillips	79	10	41.0	3.71	......
Pine Bluff	78	7	39.5	6.71	......
Sheridan	78	15	43.7	1.73	10.0
South Pass City	64	— 3	34.5	3.10	23.0
Thayne	65[k]	......	42.8[k]	1.89	......
Thermopolis	72	7	44.0	3.18	8.0
Torrington	84	18	45.1	4.35	......
Wells	54	2	32.6	1.56	7.0
Yellowstone Pk. (Foun'n)	58	6	35.4	......	......
Yellowstone Pk. (Lake)	56	—10	30.8	1.14	8.0
Yellowstone Pk. (Norris)	......	— 9	......	......	17.5
Yellowstone Pk. (U. Ba'n)	57	— 4	34.6	2.07	......
Yellowstone Pk. (Soda B.)	66	— 5	35.2	0.68	7.0
Porto Rico.					
Adjuntas	85	51	69.3	8.82	
Agua Buenas	......	......	......	2.96	
Aguirre	91	64	79.0	2.91	
Aibonito	84[d]	56[d]	71.2[d]	4.18	
Arecibo	92	55	72.2	1.85	
Barros	86	57	72.6	6.49	
Bayamon	94	60	76.4	2.33	
Caguas	90	60	75.6	1.79	
Canovanas	94	69	79.8	2.77	
Cidra	......	50	......	1.12	
Coamo	89	59	76.0	5.75	
Coloso	92	63	77.2	3.81	
Corozal	90	50	76.7	4.24	
Fajardo	90	62	77.1	2.00	
Guanica	92	62	76.8	2.65	
Hacienda Josefa	......	......	......	3.99	
Humacao	89	70	79.4	3.40	
Ingenio	......	......	......	2.46	
Isabela	93	66	78.0	2.59	
Juana Diaz	90	65	78.2	2.86	
La Carmelita	86	61	72.5	10.06	
La Ysolina	91	59	75.0	6.98	
Lares	92	55	73.4	12.15	
Las Cruces	86	58	69.8	11.92	
Las Marias	90	61	74.8	9.19	
Manati	96	62	77.5	3.91	
Maunabo	91	62	77.6	3.25	
Mayaguez	98	60	78.2	5.45	
Morovis	93	54	74.1	2.00	
Ponce[f]	89	64	77.2	1.54	
Rio Blanco	88	63	77.0[k]	7.38	
Rio Piedras	......	......	......	3.60	
San German	94	61	77.2	3.72	
San Lorenzo	93	60	76.8	4.23	
San Salvador	87	60	72.6	7.97	
Santa Isabel	92	64	77.2	2.67	
Vega Baja	94	64	77.3	3.63	
Vieques	91	70	80.0	2.28	
Yauco	88	64	77.0	5.77	
New Brunswick.					
St. John	60	24	39.2	1.23	0.1

Late reports for March, 1905.

Stations.	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Alaska.					
Copper Center	47	1	21.8	0.20	2.0
Kenai	59	10	34.2	0.57	5.0
Teikhill	50	— 5	23.4	1.31	9.7
California.					
Auburn	81	32	54.2	7.43	1.0
Colfax	89	29	50.9	9.79	4.0
Jamestown	80	28	54.5	6.80	
Kernville	......	......	......	3.90	
Laytonville	......	......	......	13.58	
Ventura	78	44	59.6	5.77	
Willows	82	45	59.6	3.55	
Colorado.					
Sugar City	......	......	......	2.46	T.
Connecticut.					
Storrs	76	5	34.2	3.45	......
Wallingford	......	......	......	3.29	......
Florida.	*	*	*	*Ins.*	*Ins.*
Hypoluxo	87	49	72.2	2.80	......
Illinois.					
Warsaw	......	......	......	1.41	T.
Indian Territory.					
Calvin	......	......	......	3.42	
Fort Gibson	......	......	......	8.45	
Tulsa	......	......	......	5.29	
Iowa.					
Whatcheer	......	......	......	0.93	0.5
Massachusetts.					
Amherst	77	1	33.0	3.66	5.5
Concord	71	1	33.1	3.22	8.3
Michigan.					
Highland	......	......	......	1.79	......
Nevada.					
Palmetto	68	14	39.5	3.68	14.5
New Hampshire.					
Littleton	65	— 2	27.1	2.03	2.0
Oklahoma.					
Frederick	88	35	58.0	2.30	
South Dakota.					
Spearfish	69	13	41.0	2.00	17.0
Texas.					
Beaumont	89	43	65.7	4.82	
Wisconsin.					
Barron	60	— 6	31.4	0.47	0.2
Hillsboro	73	— 5	33.6	2.45	4.5
Wyoming.					
Iron Mountain	59	2	34.8	0.54	3.0

EXPLANATION OF SIGNS.

* Extremes of temperature from observed readings of dry thermometer.

A numeral following the name of a station indicates the hours of observation from which the mean temperature was obtained, thus:

[1] Mean of 7 a. m. + 2 p. m. + 9 p. m. + 9 p. m. ÷ 4.
[2] Mean of 8 a. m. + 8 p. m. ÷ 2.
[3] Mean of 7 a. m. + 7 p. m. ÷ 2.
[4] Mean of 6 a. m. + 6 p. m. ÷ 2.
[5] Mean of 7 a. m. + 2 p. m. ÷ 2.
[6] Mean of readings at various hours reduced to true daily mean by special tables.

The absence of a numeral indicates that the mean temperature has been obtained from daily readings of the maximum and minimum thermometers.

An italic letter following the name of a station, as "Livingston *a*," "Livingston *b*," indicates that two or more observers, as the case may be, are reporting from the same station. A small roman letter following the name of a station, or in figure columns, indicates the number of days missing from the record; for instance, "n" denotes 14 days missing.

No note is made of breaks in the continuity of temperature records when the same do not exceed two days. All known breaks of whatever duration, in the precipitation record receive appropriate notice.

CORRECTIONS.

February, 1905, Washington, Pullman, make total precipitation 0.53 instead of 0.48.

March, 1905, New York, Palermo, make total snowfall 10.9 instead of 15.9.

The following changes have been made in the names of stations: North Carolina, Rockymount, changed to Battleboro. Oregon, Antelope, changed to Heisler.

Table III.—*Resultant winds from observations at 8 a. m. and 8 p. m., daily, during the month of April, 1905.*

Stations.	Component direction from— N.	S.	E.	W.	Resultant. Direction from—	Duration.
	Hours.	Hours.	Hours.	Hours.	°	Hours.
New England.						
Eastport, Me	14	15	10	31	s. 87 w.	21
Portland, Me	17	18	7	32	s. 88 w.	25
Concord, N. H. †	13	4	6	14	n. 42 w.	12
Northfield, Vt	24	24	5	17	w.	12
Boston, Mass	19	11	12	30	n. 66 w.	20
Nantucket, Mass	19	18	9	30	n. 87 w.	21
Block Island, R. I	16	19	11	32	s. 82 w.	21
Providence, R. I	18	12	14	29	n. 68 w.	16
Hartford, Conn	26	18	5	23	n. 66 w.	20
New Haven, Conn	19	19	12	23	w.	11
Middle Atlantic States.						
Albany, N. Y	18	20	5	25	s. 84 w.	20
Binghamton, N. Y.†	9	4	8	14	n. 50 w.	8
New York, N. Y	20	10	12	31	n. 62 w.	22
Harrisburg, Pa	21	9	13	25	n. 45 w.	17
Philadelphia, Pa	23	14	10	25	n. 59 w.	18
Scranton, Pa	26	18	9	23	n. 60 w.	16
Atlantic City, N. J	24	20	8	26	n. 77 w.	18
Cape May, N. J	21	23	10	18	s. 76 w.	8
Baltimore, Md	22	19	8	24	n. 79 w.	16
Washington, D. C	23	18	13	20	n. 54 w.	9
Lynchburg, Va	16	21	16	23	s. 54 w.	9
Mount Weather, Va	25	14	8	30	n. 64 w.	25
Norfolk, Va	16	22	17	15	s. 18 e.	6
Richmond, Va	16	23	13	25	s. 60 w.	14
Wytheville, Va	19	10	9	37	n. 42 w.	12
South Atlantic States.						
Asheville, N. C	24	20	15	22	n. 60 w.	8
Charlotte, N. C	11	28	16	21	s. 16 w.	18
Hatteras, N. C	19	19	18	24	w.	6
Raleigh, N. C	13	24	13	23	s. 42 w.	15
Wilmington, N. C	13	23	12	25	s. 52 w.	16
Charleston, S. C	10	24	13	21	s. 30 w.	16
Columbia, S. C	14	26	9	24	s. 51 w.	19
Augusta, Ga	13	25	9	24	s. 51 w.	19
Savannah, Ga	11	21	10	29	s. 62 w.	22
Jacksonville, Fla	13	24	17	23	s. 56 w.	19
Florida Peninsula.						
Jupiter, Fla	13	17	20	22	s. 27 w.	4
Key West, Fla	20	13	32	6	n. 75 e.	27
Tampa, Fla	16	12	18	26	n. 63 w.	9
Eastern Gulf States.						
Atlanta, Ga	9	22	12	28	s. 51 w.	21
Macon, Ga.†	7	12	7	13	s. 50 w.	8
Pensacola, Fla.†	6	11	11	9	s. 22 e.	5
Birmingham, Ala.†	9	9	8	11	w.	3
Mobile, Ala	13	33	14	14	s.	20
Montgomery, Ala	16	21	14	20	s. 50 w.	8
Meridian, Miss.†	8	10	7	10	s. 56 w.	4
Vicksburg, Miss	15	25	22	12	s. 45 e.	14
New Orleans, La	12	29	18	17	s. 3 e.	17
Western Gulf States.						
Shreveport, La	14	24	26	11	s. 56 e.	18
Fort Smith, Ark	11	19	23	14	s. 48 e.	12
Little Rock, Ark	19	21	18	17	s 27 e.	2
Corpus Christi, Tex	15	29	24	4	s. 55 e.	24
Fort Worth, Tex	19	23	16	17	s. 14 w.	4
Galveston, Tex	10	38	16	7	s. 18 e.	29
Palestine, Tex	16	25	15	20	s. 29 w.	10
San Antonio, Tex	18	25	24	9	s. 65 e.	17
Taylor, Tex. †	12	10	8	6	n. 45 e.	3
Ohio Valley and Tennessee.						
Chattanooga, Tenn	17	22	11	25	s. 70 w.	15
Knoxville, Tenn	20	16	15	24	n. 66 w.	10
Memphis, Tenn	18	25	15	17	s. 16 w.	7
Nashville, Tenn	19	20	12	22	s. 84 w.	10
Lexington, Ky. †	6	10	10	10	s.	4
Louisville, Ky	15	19	13	23	s. 68 w.	11
Evansville, Ind.†	9	7	8	10	n. 45 w.	3
Indianapolis, Ind	20	18	14	21	n. 74 w.	7
Cincinnati, Ohio	19	16	14	26	n. 76 w.	12
Columbus, Ohio	17	18	16	23	s. 82 w.	7
Pittsburg, Pa	28	9	8	32	n. 51 w.	31
Parkersburg, W. Va	28	12	6	26	n. 51 w.	26
Elkins, W. Va	26	14	3	28	n. 64 w.	28
Lower Lake Region.						
Buffalo, N. Y	10	24	11	32	s. 56 w.	25
Oswego, N. Y	12	18	6	33	s. 78 w.	28
Rochester, N. Y	14	16	6	35	s. 86 w.	29
Syracuse, N. Y	17	15	2	38	n. 87 w.	36
Erie, Pa	16	19	7	30	s. 83 w.	23
Cleveland, Ohio	20	16	15	22	n. 60 w.	8
Sandusky, Ohio †	5	10	7	14	s. 54 w.	9
Toledo, Ohio	15	13	15	26	n. 80 w.	11
Detroit, Mich	19	12	17	25	n. 49 w.	11
Upper Lake Region.						
Alpena, Mich	26	9	12	27	n. 42 w.	23
Escanaba, Mich	29	11	17	18	n. 3 w.	18
Grand Rapids, Mich	17	16	16	23	n. 82 w.	7
Houghton, Mich.†	13	2	10	13	n. 15 w.	11
Marquette, Mich	26	12	10	32	n. 58 w.	26
Port Huron, Mich	22	17	13	21	n. 58 w.	9
Sault Ste. Marie, Mich	22	10	12	34	n. 61 w.	25
Chicago, Ill	19	15	24	19	n. 51 e.	6
Milwaukee, Wis	24	15	11	22	n. 51 w.	14
Green Bay, Wis	22	18	19	17	n. 27 e.	4
Duluth, Minn	34	4	13	28	n. 27 w.	34

Stations.	Component direction from— N.	S.	E.	W.	Resultant. Direction from—	Duration.
	Hours.	Hours.	Hours.	Hours.	°	Hours.
North Dakota.						
Moorhead, Minn	32	15	13	16	n. 10 w.	17
Bismarck, N. Dak	28	10	17	21	n. 13 w.	18
Devils Lake, N. Dak	26	16	15	21	n. 31 w.	12
Williston, N. Dak	27	14	19	14	n. 21 w.	14
Upper Mississippi Valley.						
Minneapolis, Minn.*	12	6	4	15	n. 61 w.	12
St. Paul, Minn	30	12	10	20	n. 29 w.	21
La Crosse, Wis.†	11	12	4	4	s.	1
Madison, Wis	22	18	10	22	n. 72 w.	13
Charles City, Iowa	27	9	11	22	n. 31 w.	21
Davenport, Iowa	22	10	20	25	n. 23 w.	13
Des Moines, Iowa	27	13	16	19	n. 12 w.	14
Dubuque, Iowa	28	17	14	16	n. 10 w.	11
Keokuk, Iowa	24	17	12	20	n. 49 w.	11
Cairo, Ill	19	23	13	20	s. 60 w.	8
La Salle, Ill. †	7	7	11	10	e.	1
Peoria, Ill	12	9	6	7	n. 18 w.	3
Springfield, Ill	16	18	13	23	s. 79 w.	10
Hannibal, Mo. †	7	6	6	16	n. 84 w.	10
St. Louis, Mo	16	19	20	19	s. 18 e.	3
Missouri Valley.						
Columbia, Mo. *	10	8	7	11	n. 63 w.	4
Kansas City, Mo	23	18	15	19	n. 39 w.	6
Springfield, Mo	17	21	16	16	s.	4
Topeka, Kans.*	8	7	7	12	n. 79 w.	5
Lincoln, Nebr	29	13	18	13	n. 17 e.	17
Omaha, Nebr	31	14	14	14	n.	17
Valentine, Nebr	25	9	19	16	n. 11 e.	16
Sioux City, Iowa †	15	6	10	7	n. 18 e.	10
Pierre, S. Dak	21	15	14	25	n. 61 w.	12
Huron, S. Dak	28	12	12	19	n. 24 w.	18
Yankton, S. Dak. †	12	4	9	10	n. 7 w.	8
Northern Slope.						
Havre, Mont	21	8	22	20	n. 9 e.	13
Miles City, Mont	22	14	18	19	n. 7 w.	8
Helena, Mont	21	12	3	39	n. 76 w.	37
Kalispell, Mont	21	17	4	29	n. 81 w.	25
Rapid City, S. Dak	24	8	19	19	n.	16
Cheyenne, Wyo	30	12	11	23	n. 34 w.	22
Lander, Wyo	16	18	13	23	s. 79 w.	10
Yellowstone Park, Wyo	22	23	4	28	s. 88 w.	24
North Platte, Nebr	25	12	15	18	n. 13 w.	13
Middle Slope.						
Denver, Colo	26	16	8	17	n. 42 w.	14
Pueblo, Colo	20	13	22	19	n. 23 e.	8
Concordia, Kans	18	22	12	20	s. 63 w.	9
Dodge, Kans	20	19	15	17	n. 63 w.	2
Wichita, Kans	22	21	18	11	n. 82 e.	7
Oklahoma, Okla	22	20	18	13	n. 68 e.	5
Southern Slope.						
Abilene, Tex	17	28	9	25	s. 69 w.	17
Amarillo, Tex	16	26	17	19	s. 11 w.	10
Roswell, N. Mex	18	23	14	20	s. 50 w.	8
Southern Plateau.						
El Paso, Tex	17	6	18	32	n. 52 w.	18
Santa Fe, N. Mex	22	19	19	18	n. 18 e.	3
Flagstaff, Ariz	18	19	5	32	s. 88 w.	27
Phoenix, Ariz	13	8	31	17	n. 70 e.	15
Yuma, Ariz	7	30	16	15	s. 2 e.	23
Independence, Cal	23	20	14	21	n. 67 w.	8
Middle Plateau.						
Carson City, Nev	16	22	3	35	s. 79 w.	33
Winnemucca, Nev	19	22	17	21	s. 53 w.	5
Modena, Utah	10	8	12	38	n. 86 w.	26
Salt Lake City, Utah	21	16	22	16	n. 50 e.	8
Durango, Colo	23	9	4	38	n. 68 w.	37
Grand Junction, Colo	20	20	19	15	e.	4
Northern Plateau.						
Baker City, Oreg	22	22	22	18	e.	4
Boise, Idaho	21	13	21	21	n.	8
Lewiston, Idaho †	1	7	19	6	s. 65 e.	14
Pocatello, Idaho	7	23	22	18	s. 14 e.	16
Spokane, Wash	16	23	19	20	s. 8 w.	7
Walla Walla, Wash	5	35	18	15	s. 6 e.	30
North Pacific Coast Region.						
North Head, Wash	73	13	12	24	n. 50 w.	16
Port Crescent, Wash.*	9	4	5	19	n. 70 w.	15
Seattle, Wash	22	13	21	18	n. 18 e.	10
Tacoma, Wash	29	14	7	19	n. 39 w.	19
Tatoosh Island, Wash	15	14	19	23	n. 76 w.	4
Portland, Oreg	21	13	7	33	n. 73 w.	27
Roseburg, Oreg	29	8	15	20	n. 13 w.	22
Middle Pacific Coast Region.						
Eureka, Cal	23	19	14	16	n. 27 w.	4
Mount Tamalpais, Cal	22	11	3	39	n. 73 w.	38
Red Bluff, Cal	26	22	11	13	n. 27 w.	4
Sacramento, Cal	13	32	17	10	s. 20 e.	20
San Francisco, Cal	4	12	6	46	s. 79 w.	41
South Pacific Coast Region.						
Fresno, Cal	38	3	7	28	n. 31 w.	41
Los Angeles, Cal	11	16	22	26	s. 39 w.	6
San Diego, Cal	13	15	11	32	s. 85 w.	21
San Luis Obispo, Cal	25	8	5	32	n. 57 w.	32
West Indies						
Hamilton, Bermuda	18	21	4	29	s. 83 w.	25
Havana, Cuba†	4	5	25	2	s. 88 e.	23
San Juan, Porto Rico	2	25	32	2	s. 53 e.	38

* From observations at 8 p. m. only. † From observations at 8 a. m. only.

TABLE IV.—*Accumulated amounts of precipitation for each 5 minutes, for storms in which the rate of fall equaled or exceeded 0.25 in any 5 minutes, or 0.75 in 1 hour during April, 1905, at all stations furnished with self-registering gages.*

Stations.	Date.	Total duration. From—	Total duration. To—	Total amount of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive began.	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
	1	2	3	4	5	6	7														
Albany, N. Y.	11-12			0.64														0.23			
Alpena, Mich.	28-29			0.80														0.27			
Amarillo, Tex.	1			1.09														0.50			
Asheville, N. C.	29			0.51						0.42											
Atlanta, Ga.	29			0.72						0.45											
Atlantic City, N. J.	11-12			1.09														0.37			
Augusta, Ga.	12-13	6:35 p. m.	3:50 a. m.	1.07	7:11 p. m.	7:53 p. m.	0.04	0.11	0.21	0.24	0.30	0.41	0.59	0.79	0.86						
Do	22	9:29 p. m.	10:15 p. m.	0.93	9:33 p. m.	9:55 p. m.	T.	0.33	0.64	0.78	0.88	0.90									
Baltimore, Md.	4			0.52														*			
Binghamton, N. Y.	4-5			0.56														0.11			
Birmingham, Ala.	4			0.98														0.59			
Bismarck, N. Dak.	27			0.07														0.07			
Block Island, R. I.	5-6			0.76														0.25			
Boise, Idaho.	26			0.13														0.09			
Boston, Mass.	5-6			0.63														0.37			
Buffalo, N. Y.	20-21			1.30														*			
Cairo, Ill.	10-11			0.78														0.41			
Charleston, S. C.	15	3:27 p. m.	4:55 p. m.	0.74	4:42 p. m.	4:55 p. m.	0.06	0.12	0.47	0.68											
Do	29	5:13 p. m.	8:30 p. m.	0.81	5:19 p. m.	5:34 p. m.	T.	0.21	0.55	0.66											
Charlotte, N. C.	5			0.64														0.45			
Chattanooga, Tenn.	29			0.62														0.48			
Chicago, Ill.	29			1.65														0.34			
Cincinnati, Ohio.	28			0.70														0.56			
Cleveland, Ohio.	20-21			0.98														0.21			
Columbia, Mo.	28			0.37					0.35												
Columbia, S. C.	12-13	6:12 p. m.	D. N.	3.59	6:45 p. m.	8:30 p. m.	T.	0.05	0.22	0.46	0.59	0.75	1.00	1.20	1.40	1.59	1.82	1.98	2.74	3.35	
Do	21	5:06 p. m.	6:16 p. m.	1.06	5:13 p. m.	5:33 p. m.	T.	0.16	0.43	0.65	0.97										
Do	29	2:58 p. m.	5:35 p. m.	0.80	3:25 p. m.	3:45 p. m.	0.06	0.21	0.39	0.52	0.58										
Columbus, Ohio.	26			0.32						0.29											
Concord, N. H.	4-6			0.91														0.19			
Corpus Christi, Tex.	29	1:02 a. m.	6:14 a. m.	1.86	1:30 a. m.	2:18 a. m.	0.01	0.05	0.14	0.25	0.42	0.61	0.88	1.11	1.44	1.78	1.83				
Davenport, Iowa.	20			1.83														0.27			
Denver, Colo.	23-24			2.30														0.15			
Des Moines, Iowa.	19-20			1.36														0.22			
Detroit, Mich.	20-21			1.50														0.32			
Dodge, Kans.	22-23			2.65														0.40			
Dubuque, Iowa.	20-21			1.37														0.25			
Duluth, Minn.	27			0.61														0.25			
Eastport, Me.	6			0.33														0.11			
Elkins, W. Va.	27			0.39														0.34			
Erie, Pa.	20-21			1.61														0.32			
Escanaba, Mich.	28-29			0.67														*			
Evansville, Ind.	28			0.78														0.73			
Fort Smith, Ark.	1-2			1.65														*			
Fort Worth, Tex.	23-24	7:05 p. m.	7:15 a. m.	2.72	7:16 p. m.	7:34 p. m.	0.01	0.16	0.32	0.42	0.48	0.61	0.70	0.75	0.78	0.80	0.84	0.94			
Do	29-30	4:27 p. m.	6:00 a. m.	2.76	12:42 a. m.	1:27 a. m.	1.04	0.08	0.17	0.28	0.34	0.39	0.53	0.70	0.80	0.91					
Galveston, Tex.	24	5:10 a. m.	1:50 p. m.	1.67	10:53 a. m.	12:19 p. m.	0.29	0.13	0.18	0.27	0.37	0.43	0.47	0.49	0.67	0.73	0.81	0.99	1.19		
Do	29	6:00 p. m.	11:45 p. m.	3.72	8:55 p. m.	9:55 p. m.	1.05	0.13	0.25	0.43	0.67	0.93	1.24	1.59	1.88	2.08	2.14	2.28			
Grand Rapids, Mich.	20-21			1.06														0.23			
Green Bay, Wis.	4			0.68														*			
Hannibal, Mo.	28	12:56 p. m.	3:40 p. m.	1.45	1:52 p. m.	2:20 p. m.	0.09	0.15	0.34	0.54	0.71	0.96	1.08								
Harrisburg, Pa.	27			0.22							0.19										
Hatteras, N. C.	26			1.23						0.53											
Huron, S. Dak.	13			0.18														*			
Indianapolis, Ind.	20-21			0.62														0.33			
Jacksonville, Fla.	12			0.90														0.40			
Jupiter, Fla.	21-22			2.47														0.46			
Kalispell, Mont.	8-9			0.29														*			
Kansas City, Mo.	24-25			1.13														0.22			
Key West, Fla.	4			0.76														0.42			
Knoxville, Tenn.	25-26			1.23					0.56												
La Crosse, Wis.	3-4			0.31														0.08			
Lexington, Ky.	21			0.87														0.48			
Lincoln, Nebr.	20			0.97														0.20			
Little Rock, Ark.	24	3:17 p. m.	11:30 p. m.	2.30	5:15 p. m.	6:25 p. m.	0.41	0.05	0.12	0.22	0.35	0.45	0.53	0.56	0.74	1.05	1.19	1.30	1.40		
Do	29	2:59 a. m.	7:55 a. m.	1.01	3:11 a. m.	3:31 a. m.	0.07	0.22	0.39	0.57	0.64										
Los Angeles, Cal.	11			0.18														0.10			
Louisville, Ky.	28			0.41														0.40			
Lynchburg, Va.	4-5			0.84														0.15			
Macon, Ga.	12	2:25 p. m.	10:45 p. m.	0.97	2:35 p. m.	3:10 p. m.	T.	0.08	0.15	0.21	0.28	0.36	0.45	1.53							
Memphis, Tenn.	25	6:50 p. m.	10:15 p. m.	0.87	7:50 p. m.	8:05 p. m.	0.15	0.17	0.38	0.68											
Meridian, Miss.	21			0.66						0.44											
Milwaukee, Wis.	10			0.25														0.17			
Minneapolis, Minn.	2			0.54														0.19			
Montgomery, Ala.	8			0.49														0.32			
Nantucket, Mass.	21-22			0.28														0.19			
Nashville, Tenn.	28			0.34					0.34												
New Haven, Conn.	5-6			1.51														0.21			
New Orleans, La.	24-25	8:40 p. m.	3:30 a. m.	2.07	11:50 p. m.	1:00 a. m.	0.59	0.15	0.26	0.37	0.47	0.53	0.56	0.59	0.73	0.89	0.94	1.06	1.31		
New York, N. Y.	4-5			0.79														0.23			
Norfolk, Va.	12-13			1.74														0.38			
Northfield, Vt.	21			0.80														0.19			
North Head, Wash.	16			0.35														0.18			
Oklahoma, Okla.	11	11:55 a. m.	11:15 p. m.	2.87	4:39 p. m.	5:03 p. m.	1.66	0.07	0.17	0.23	0.30	0.55									
Omaha, Nebr.	19-20			2.11														0.72			
Palestine, Tex.	23-24	11:00 p. m.	10:50 a. m.	2.51	5:55 a. m.	6:40 a. m.	0.66	0.19	0.28	0.40	0.49	0.54	0.63	0.75	0.87	0.92					
Parkersburg, W. Va.	20			0.32														0.22			
Pensacola, Fla.	4	7:05 a. m.	10:50 a. m.	1.19	7:48 a. m.	8:32 a. m.	0.04	0.12	0.22	0.43	0.47	0.51	0.60	0.78	0.97	1.05					
Philadelphia, Pa.	10-11			0.63														0.51			
Pittsburg, Pa.	21			0.26														0.25			
Pocatello, Idaho.	3			0.25														0.17			
Portland, Me.	5-6			1.05														0.21			
Portland, Oreg.	15			0.27														0.26			
Pueblo, Colo.	23-24			2.26														0.20			
Raleigh, N. C.	5			0.71						0.62											
Richmond, Va.	11			0.42														0.27			
Rochester, N. Y.	21			0.87														0.17			
Sacramento, Cal.	15			0.64														0.24			
St. Louis, Mo.	28			0.37														0.23			
St. Paul, Minn.	2			0.17														0.09			
Salt Lake City, Utah.	10			0.39														0.22			

TABLE IV.—*Accumulated amounts of precipitation for each 5 minutes, etc.*—Continued.

Stations.	Date.	Total duration. From—	Total duration. To—	Total amount of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive began.	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
	1	2	3	4	5	6	7														
San Antonio, Tex	23-24	9:40 p. m.	7:05 a. m.	2.75	12:58 a. m.	2:33 a. m.	0.07	0.07	0.20	0.36	0.66	0.87	0.98	1.07	1.16	1.24	1.38	1.67	1.92	2.24	
San Diego, Cal	26			0.13														0.07			
Sandusky, Ohio	20-21			1.79														0.27			
San Francisco, Cal	15			0.36														0.21			
Savannah, Ga	15			0.52														0.25			
Scranton, Pa	5-6			0.66														0.05			
Seattle, Wash	19			0.42														0.13			
Shreveport, La	2-3	5:50 p. m.	2:15 a. m.	2.01	12:01 a. m.	12:50 a. m.	0.49	0.06	0.14	0.15	0.18	0.36	0.43	0.70	1.05	1.23	1.31				
Do	10	9:55 a. m.	2:00 p. m.	1.36	11:07 a. m.	12:37 p. m.	0.07	0.07	0.16	0.19	0.28	0.42	0.52	0.64	0.66	0.67	0.84	0.94	1.10	1.22	
Do	11	1:20 a. m.	9:15 a. m.	2.58	3:07 a. m.	4:32 a. m.	0.26	0.09	0.24	0.53	0.85	1.14	1.27	1.36	1.48	1.54	1.60	1.71	2.00	2.13	
Do	24	9:25 a. m.	3:30 p. m.	1.26	12:10 p. m.	1:00 p. m.	0.25	0.10	0.19	0.37	0.43	0.50	0.56	0.59	0.64	0.71	0.76				
Spokane, Wash	18-19			0.54														0.10			
Springfield, Ill	25-26			1.30														0.36			
Springfield, Mo	20	5:17 p. m.	6:25 p. m.	0.95	5:17 p. m.	6:20 p. m.	0.00	0.07	0.08	0.16	0.20	0.28	0.32	0.42	0.50	0.60	0.65	0.86	0.95		
Syracuse, N. Y	4-5			0.59														0.22			
Tampa, Fla	15			0.79														0.26			
Taylor, Tex.	29	2:00 p. m.	6:10 p. m.	3.28	2:42 p. m.	3:12 p. m.	0.06	0.45	1.35	2.25	2.75	2.83	2.89								
Toledo, Ohio	20-21			1.99														0.34			
Topeka, Kans	20			0.44														0.40			
Vicksburg, Miss	24-25	4:27 p. m.	D. N.	2.53	6:58 p. m.	7:18 p. m.	0.60	0.33	0.41	0.50	0.62										
Do	29	6:20 a. m.	11:54 a. m.	1.86	7:41 a. m.	8:16 a. m.	0.20	0.09	0.20	0.48	0.55	0.65	0.88	0.99							
Washington, D. C	4-5			1.54														0.35			
Wichita, Kans	1			1.59														0.60			
Williston, N. Dak	28			0.03																	
Wilmington, N. C	5			1.04									0.49								
Wytheville, Va	5			0.54														0.16			
Yankton, S. Dak	28			0.49														0.12			
Havana, Cuba	11	3:05 p. m.	4:15 p. m.	0.78	3:10 p. m.	3:45 p. m.	T.	0.08	0.15	0.36	0.48	0.57	0.67	0.74							
Do	12	2:30 p. m.	5:00 p. m.	0.75	3:13 p. m.	3:35 p. m.	0.03	0.22	0.35	0.43	0.47	0.53									
San Juan, Porto Rico	26			0.41							0.39										

*Self-register not working

TABLE V.—*Data furnished by the Canadian Meteorological Service, April, 1905.*

Stations.	Pressure, in inches. Actual, reduced to mean of 24 hours.	Pressure. Sea level, reduced to mean of 24 hours.	Pressure. Departure from normal.	Temperature. Mean.	Temperature. Departure from normal.	Temperature. Mean maximum.	Temperature. Mean minimum.	Precipitation. Total.	Precipitation. Departure from normal.	Precipitation. Total snowfall.
	Ins.	Ins.	Ins.	°	°	°	°	Ins.	Ins.	Ins.
St. Johns, N. F	29.52	29.66	—.23	36.2	+ 1.7	42.3	30.0	3.83	—0.33	5.0
Sydney, C. B. I	29.70	29.74	—.15	36.5	+ 1.5	44.4	28.7	2.76	—1.09	4.0
Halifax, N. S	29.67	29.78	—.18	39.6	+ 1.8	47.4	31.7	1.26	—2.92	0.2
Grand Manan, N. B	29.70	29.76	—.18	39.7	+ 0.5	46.8	32.7	1.23	—1.73	
Yarmouth, N. S	29.73	29.80	—.16	39.7	+ 0.8	45.9	33.4	1.27	—2.12	1.8
Charlottetown, P. E. I	29.70	29.74	—.16	37.4	+ 2.2	44.1	30.6	1.69	—0.96	9.5
Chatham, N. B	29.68	29.70	—.20	40.9	+ 5.4	51.3	30.5	1.03	—1.60	3.6
Father Point, Que	29.68	29.70	—.23	37.4	+ 4.2	44.8	30.1	1.76	+0.18	0.4
Quebec, Que	29.43	29.75	—.24	38.4	+ 3.3	47.1	29.6	1.54	—0.55	1.9
Montreal, Que	29.59	29.80	—.20	41.9	+ 2.2	49.9	33.9	1.34	—0.90	2.5
Rockliffe, Ont.	29.21	29.76	—.26	39.4	+ 1.5	50.9	28.0	1.01	—0.55	0.3
Ottawa, Ont	29.45	29.77	—.25	41.8	+ 1.8	51.6	31.9	0.95	—0.55	0.8
Kingston, Ont	29.54	29.86	—.16	38.9	— 1.1	47.0	30.8	1.54	—0.25	1.8
Toronto, Ont	29.50	29.89	—.13	42.2	+ 1.4	51.1	33.2	1.43	—0.94	3.5
White River, Ont	28.55	29.90	—.14	30.9	— 2.1	41.0	20.8	1.05	—0.20	6.6
Port Stanley, Ont	29.27	29.93	—.09	39.6	— 1.4	48.2	31.0	2.03	—0.44	1.9
Saugeen, Ont	29.17	29.89	—.14	39.6	+ 0.9	48.8	30.3	0.79	—1.01	2.6

Stations.	Pressure, in inches. Actual, reduced to mean of 24 hours.	Pressure. Sea level, reduced to mean of 24 hours.	Pressure. Departure from normal.	Temperature. Mean.	Temperature. Departure from normal.	Temperature. Mean maximum.	Temperature. Mean minimum.	Precipitation. Total.	Precipitation. Departure from normal.	Precipitation. Total snowfall.
	Ins.	Ins.	Ins.	°	°	°	°	Ins.	Ins.	Ins.
Parry Sound, Ont	29.10	29.88	—.17	40.3	+ 2.7	48.6	32.0	0.99	—0.92	T.
Port Arthur, Ont	29.20	29.92	—.11	35.2	+ 1.7	44.4	26.1	1.32	—0.40	6.3
Winnipeg, Man	29.13	29.97	—.05	38.4	+ 2.5	49.7	27.0	0.25	—0.80	1.2
Minnedosa, Man	28.15	30.00	—.01	38.7	+ 2.7	52.1	25.4	0.13	—0.93	0.9
Qu'Appelle, Assin	27.69	29.96	—.03	38.7	+ 1.3	52.9	24.6	0.68	—0.37	6.8
Medicine Hat, Assin	27.06	29.95	+.03	45.8	+ 1.3	60.3	31.4	0.30	—0.44	0.5
Swift Current, Assin										
Calgary, Alberta	28.40	29.97	+.07	39.5	— 0.1	53.7	25.3	0.80	+0.16	8.0
Banff, Alberta	25.34	29.97	+.07	37.9	+ 2.6	50.6	25.2	0.56	—0.52	5.0
Edmonton, Alberta	27.62	29.92	+.03	43.3	+ 3.4	57.8	28.7	0.01	—0.87	T.
Prince Albert, Sask	28.35	29.93	—.05	38.7	+ 2.6	52.6	24.9	0.35	—0.48	3.5
Battleford, Sask	28.23	29.99	+.02	40.8	+ 3.6	55.4	26.2	0.10	—0.37	0.5
Kamloops, B. C.	28.68	29.90	—.03	50.9	+ 2.0	64.8	37.0	0.46	+0.07	
Victoria, B. C.	29.92	30.02	+.01	50.3	+ 3.5	57.5	43.1	0.21	—2.16	
Barkerville, B. C.	25.61	29.93	+.07	37.0	+ 3.9	49.1	24.9	2.18	+0.36	14.0
Hamilton, Bermuda	29.91	30.07	+.02	65.6	+ 1.7	71.2	59.9	6.80	+2.62	

TABLE VI.—*Heights of rivers referred to zeros of gages, April, 1905.*

Stations.	Distance to mouth of river.	Danger line on gage.	Highest water. Height.	Highest water. Date.	Lowest water. Height.	Lowest water. Date.	Mean stage.	Monthly range.
	Miles.	Feet.	Feet.		Feet.		Feet.	Feet.
Milk River.								
Havre, Mont.	237	9	3.8	30	3.2	11	3.4	0.6
Musselshell River.								
Musselshell, Mont.	87	9						
Yellowstone River.								
Billings, Mont.	330	8	0.7	29	— 0.5	8, 9	—0.1	1.2
Glendive, Mont.	78	17	1.6	25, 26	0.9	10–13	1.2	0.7
Cheyenne River.								
Rosseau, S. Dak.	7	9	1.6	5	— 0.2	28–30	0.4	1.8
James River.								
Lamoure, N. Dak	330	14	— 1.2	1–6	— 2.1	20-22,29,30	—1.7	0.9
Huron, S. Dak.	139	9	0.8	2	0.5	13	6.4	0.3
Big Blue River.								
Blue Rapids, Kans.	42	18	8.5	26	5.1	11-14,19-21	5.6	3.4
Republican River.								
Clay Center, Kans.	45	22	8.4	28, 29	6.9	9,16,20-22	7.3	1.5
Solomon River.								
Beloit, Kans	75	16	1.9	5	0.9	8	1.4	1.0
Smoky Hill River.								
Lindsborg, Kans	109	20	3.1	2	1.8	8,11,13,19	2.2	1.3
Abilene, Kans.	45	22	2.6	15	1.4	19	1.9	1.2

Stations.	Distance to mouth of river.	Danger line on gage.	Highest water. Height.	Highest water. Date.	Lowest water. Height.	Lowest water. Date.	Mean stage.	Monthly range.
	Miles.	Feet.	Feet.		Feet.		Feet.	Feet.
Kansas River.								
Manhattan, Kans.	160	18	5.4	27	3.0	18, 21, 22	3.5	2.4
Topeka, Kans.	87	21	7.9	30	6.5	15–18	6.9	1.4
Osage River.								
Bagnell, Mo.	70	28	5.8	6	2.4	21, 24, 30	3.3	3.4
Gasconade River.								
Arlington, Mo.	98	16	1.0	28	0.3	23–25	0.5	0.7
Missouri River.								
Townsend, Mont.	2,504	11	3.9	23–30	3.6	5–10	3.8	0.3
Fort Benton, Mont.	2,285	12	1.4	21–30	1.0	1–14		0.4
Wolf Point, Mont	1,932	17	— 0.8	1, 2	— 1.3	25, 26	—1.2	0.5
Bismarck, N. Dak.	1,309	14	0.8	1–6	0.0	16–22	0.3	0.8
Pierre, S. Dak.	1,114	14	3.2	6, 7	2.3	24, 25	2.7	0.9
Sioux City, Iowa	784	19	7.2	1	5.0	25–27	6.0	2.2
Blair, Nebr	705	15	7.3	1	5.6	16–19	6.0	1.7
Omaha, Nebr	669	10	8.7	1	6.2	29, 30	6.8	2.5
Plattsmouth, Nebr.	641	17	4.9	1	3.0	17–20	3.7	1.9
St. Joseph, Mo	481	10	5.1	1	1.3	21	2.7	3.8
Kansas City, Mo.	388	21	12.9	1	7.6	22, 23	9.3	5.3
Glasgow, Mo.	231	18	10.4	30	4.8	20, 22	6.8	5.6
Boonville, Mo.	199	20	11.8	2	7.3	22	9.1	4.5

TABLE VI.—*Heights of rivers referred to zeros of gages.*—Continued.

Stations.	Distance to mouth of river.	Danger line on gage.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Missouri River—Cont'd.	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Hermann, Mo.	103	24	12.0	1	7.3	23	9.1	4.7
Minnesota River.								
Mankato, Minn.	127	18	5.2	6, 7	2.9	29, 30	4.0	2.3
St. Croix River.								
Stillwater, Minn.	23	11	8.1	9	3.9	29	6.0	4.2
Chippewa River.								
Chippewa Falls, Wis.	77	14	8.3	1	1.2	23	3.7	7.1
Red Cedar River.								
Cedar Rapids, Iowa	57	......	4.9	1	3.8	17-20, 29, 30	4.1	1.1
Iowa River.								
Iowa City, Iowa.	205	19	3.3	1	0.8	19	1.9	2.5
Des Moines River.								
Des Moines, Iowa.	135	14	6.0	7	4.0	18, 19, 21	4.8	2.0
Illinois River.								
Peoria, Ill.	35	8	14.2	1, 2	11.9	19, 20	13.2	2.3
Beardstown, Ill	70	12	11.8	1-3	10.7	19, 20	11.3	1.1
Red Bank Creek.								
Brookville, Pa.	42	......	1.4	1-9	1.0	10, 14-30	1.1	0.4
Clarion River.								
Clarion, Pa.	32	10	4.3	22	1.0	20	2.4	3.3
Conemaugh River.								
Johnstown, Pa.	64	7	5.6	11	2.3	5, 6, 20, 21, 27, 28	2.8	3.3
Allegheny River.								
Warren, Pa.	177	14	6.5	22	1.6	18-20	3.0	4.9
Franklin, Pa	114	15	7.2	22	2.4	11	3.6	4.8
Parker, Pa.	73	20	7.1	23	2.3	16-18	3.5	4.8
Freeport, Pa.	29	20	12.0	23	4.8	20	7.4	7.2
Springdale, Pa.	17	27	15.0	23	9.1	20	11.1	5.9
Cheat River.								
Rowlesburg, W. Va.	36	14	3.2	28, 29	2.1	5	2.6	1.1
Youghiogheny River.								
Confluence, Pa.	59	10	2.8	12, 22	1.3	6, 20	1.9	1.5
West Newton, Pa.	15	23	4.6	12	1.8	4, 5	2.6	2.8
Monongahela River.								
Weston, W. Va.	161	18	1.2	12	— 0.2	4, 5	0.4	1.4
Fairmont, W. Va.	119	25	16.9	24, 28	14.9	5	15.8	2.0
Greensboro, Pa.	81	18	10.4	12	7.6	5	8.8	2.8
Lock No. 4, Pa.	40	28	11.9	12	7.4	5	9.2	4.5
Beaver River.								
Ellwood Junction, Pa.	10	14	4.8	11, 12	3.6	20	3.9	1.2
Muskingum River.								
Zanesville, Ohio	70	25	11.6	23	8.4	19, 20	9.2	3.2
Little Kanawha River.								
Glenville, W. Va	77	20	3.0	27, 29, 30	0.0	18-21	1.3	3.0
Creston, W. Va.	38	20	5.9	28	3.2	6, 19-21	4.0	2.7
New River.								
Radford, Va	155	14	2.2	7	0.6	30	1.0	1.6
Hinton, W. Va.	95	14	4.0	7, 8	1.8	24-28	2.5	2.2
Great Kanawha River.								
Charleston, W. Va.	58	30	9.5	7	4.5	5, 6, 20	6.5	5.0
Scioto River.								
Columbus, Ohio	110	17	5.8	22	2.5	8-16	3.1	3.3
Licking River.								
Falmouth, Ky.	30	25	5.5	13	2.0	22	3.2	3.5
Miami River.								
Dayton, Ohio	77	18	4.7	22	1.0	9, 10	1.9	3.7
Kentucky River.								
Jackson, Ky	287	24	6.5	28-30	5.0	1-5	5.4	1.5
Beattyville, Ky	254	30	3.4	28, 29	1.2	20, 25	1.7	2.2
High Bridge, Ky	117	17	12.6	30	10.0	20, 21	10.7	2.6
Frankfort, Ky.	65	31	8.0	30	6.5	21, 23	7.0	1.5
Wabash River.								
Terre Haute, Ind	171	16	13.1	24	1.0	18-20	4.7	12.1
Mount Carmel, Ill	75	15	10.6	27	4.0	22-24	6.4	6.6
Cumberland River.								
Burnside, Ky.	518	50	7.8	11	2.6	21, 22	4.7	5.2
Celina, Tenn	383	45	9.6	13	4.7	24	6.8	4.9
Carthage, Tenn.	308	40	7.0	13, 14	3.8	22	5.4	3.2
Nashville, Tenn	193	40	11.6	1, 15	9.4	23-26	10.6	2.2
Clarksville, Tenn.	126	42	13.7	1	7.5	25, 26	10.6	6.2
Powell River.								
Tazewell, Tenn.	44	20	2.5	10	1.0	8	1.7	1.5
Clinch River.								
Speers Ferry, Va.	156	20	3.1	7	0.3	3, 4	0.9	2.8
Clinton, Tenn	52	25	9.0	13	4.9	4-6	6.4	4.1
South Fork Holston River.								
Bluff City, Tenn.	35	15	3.7	6	1.0	25, 26	1.7	2.7
Holston River.								
Rotherwood, Tenn.	142	14	2.7	7	0.9	3, 4	1.5	1.8
Rogersville, Tenn.	103	14	4.0	7	2.1	27, 28	2.8	1.9
French Broad River.								
Asheville, N. C.	144	6	0.6	13	— 0.4	4, 24, 25	—0.1	1.0
Leadvale, Tenn. (a)	70	15	2.4	13	— 0.6	1	0.4	3.0
Dandridge, Tenn.	46	15	3.5	13	1.0	3, 4	1.7	2.5
Little Tennessee River.								
McGhee, Tenn.	17	20	6.5	30	3.4	25	4.1	3.1
Hiwassee River.								
Charleston, Tenn	18	22	9.5	30	1.6	25	2.6	7.9
Tennessee River.								
Knoxville, Tenn.	635	29	5.4	13, 14	1.7	4, 5	3.0	3.7
Loudon, Tenn.	590	25	4.7	14	2.0	4, 5, 26	2.9	2.7
Kingston, Tenn.	556	25	5.4	14	2.6	4, 5	3.6	2.8
Chattanooga, Tenn.	452	33	7.8	15	4.3	5	5.6	3.5
Bridgeport, Ala.	402	24	5.6	15, 30	2.7	26	3.9	2.9
Guntersville, Ala.	349	31	9.1	16	5.3	6-8	6.8	3.8
Florence, Ala.	255	16	5.3	17	3.0	8, 9	3.8	2.3
Riverton, Ala.	225	26	8.3	18	5.5	26, 27	6.5	2.8
Johnsonville, Tenn.	95	21	7.3	19	5.0	10, 11, 26-28	5.9	2.3
Ohio River.								
Pittsburg, Pa.	966	22	9.5	23	3.7	20	5.9	5.8
Davis Island Dam, Pa.	960	25	10.4	23	6.0	20	7.8	4.4
Beaver Dam, Pa	925	27	14.7	24	7.7	20	10.4	7.0
Wheeling, W. Va.	875	36	14.3	24	7.3	20, 21	9.9	7.0
Parkersburg, W. Va	785	36	15.0	1	8.0	18-20	10.5	7.0
Ohio River—Cont'd.	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Point Pleasant, W. Va.	703	39	19.0	1	7.4	21, 22	12.2	11.6
Huntington, W. Va.	660	50	23.8	1	11.2	22	16.6	12.6
Catlettsburg, Ky.	651	50	24.4	1	10.5	22	16.3	13.9
Portsmouth, Ohio	612	50	25.8	1	11.6	22	17.3	14.2
Maysville, Ky.	559	50	27.3	1	11.7	23	......	15.6
Cincinnati, Ohio.	499	50	31.3	1	14.0	24	19.7	17.3
Madison, Ind	413	46	28.0	1	12.8	25	17.2	15.2
Louisville, Ky.	367	28	11.1	1	6.0	25	7.5	5.1
Evansville, Ind	184	35	33.5	1	11.6	27, 28	16.7	21.9
Mount Vernon, Ind	148	35	32.4	1	11.8	27, 28	16.5	20.6
Paducah, Ky.	47	40	27.1	1	12.2	26, 27	16.6	14.9
Cairo, Ill.	1	45	34.7	2, 3	21.7	25, 26	26.0	13.0
St. Francis River.								
Marked Tree, Ark.	104	17	13.9	6, 12	12.5	30	13.4	1.4
Neosho River.								
Neosho Rapids, Kans.	326	22	2.4	27	0.4	20-24	0.9	2.0
Iola, Kans.	262	10	2.7	1	0.4	20-24	0.8	2.3
Oswego, Kans.	184	20	7.4	1	0.3	26	1.4	7.1
Fort Gibson, Ind. T	3	22	14.7	4	10.8	26-30	11.9	3.9
Canadian River.								
Calvin, Ind. T	99	10	6.5	28	1.5	1	3.1	5.0
Black River.								
Blackrock, Ark.	67	12	16.6	26	8.0	24	11.3	8.6
White River.								
Calicorock, Ark	272	15	8.3	6	2.5	24, 25	4.3	5.8
Batesville, Ark.	217	18	10.5	7	4.9	24	6.7	5.6
Newport, Ark.	185	26	17.2	8	8.2	24	12.6	9.0
Clarendon, Ark.	75	30	25.2	15-17	22.9	2, 3	24.4	2.3
Arkansas River.								
Wichita, Kans.	832	10	5.3	29-30	0.8	1, 7	1.7	4.5
Tulsa, Ind. T.	551	16	5.8	5	3.0	29, 30	3.8	2.8
Webbers Falls, Ind. T	465	23	10.0	5	5.6	24-28, 30	7.0	4.4
Fort Smith, Ark.	403	22	13.1	6	6.4	24	9.1	6.7
Dardanelle, Ark.	256	21	13.8	5	7.0	25	9.5	6.8
Little Rock, Ark	176	23	15.8	6	9.4	22, 25	11.6	6.4
Yazoo River.								
Greenwood, Miss	175	38	25.9	1	21.2	30	23.8	4.7
Yazoo City, Miss.	80	25	21.5	4	18.2	25	20.2	3.3
Ouachita River.								
Camden, Ark.	304	39	32.4	29	21.8	12	28.1	10.6
Monroe, La	122	40	38.3	30	33.8	1, 2	35.8	4.5
Red River.								
Arthur City, Tex.	688	27	17.4	29	7.6	14, 15	11.3	9.8
Kiomache, Tex	614	27	17.7	4	4.7	13	9.2	13.0
Fulton, Ark.	515	28	26.8	30	16.9	16	21.5	9.9
Spring Bank, Ark.	441	29	28.8	30	22.6	1	26.4	6.2
Shreveport, La.	327	29	19.1	12, 30	13.4	1	17.6	5.7
Alexandria, La.	118	33	28.6	15, 16	22.0	3	26.9	6.6
Mississippi River.								
St. Cloud, Minn.	2,034	4	1.5	7, 8	0.3	1, 28	0.9	1.2
St. Paul, Minn.	1,954	14	6.7	10-12	3.8	28-30	5.1	2.9
Red Wing, Minn.	1,914	14	6.5	9, 10	2.8	30	5.0	3.7
Reeds Landing, Minn	1,884	12	6.4	2	2.8	30	4.9	3.6
La Crosse, Wis	1,819	12	8.4	3, 5	4.2	30	6.8	4.2
Prairie du Chien, Wis.	1,759	18	11.3	8, 9	5.0	30	8.9	6.3
Dubuque, Iowa	1,699	18	12.2	10, 11	6.0	30	9.9	6.2
Clinton, Iowa.	1,629	16	11.1	12, 13	6.1	30	9.3	5.0
Leclaire, Iowa.	1,609	10	7.5	12, 13	4.2	30	6.4	3.3
Davenport, Iowa.	1,593	15	10.4	12, 13	5.8	30	8.9	4.6
Muscatine, Iowa	1,562	16	11.8	13	7.3	30	10.4	4.5
Galland, Iowa	1,472	8	6.3	1	4.2	30	5.5	2.1
Keokuk, Iowa.	1,463	15	11.0	1	7.7	30	9.6	3.3
Warsaw, Ill.	1,458	18	13.9	1	10.8	30	12.6	3.1
Hannibal, Mo	1,402	13	12.5	1	9.8	30	11.1	2.7
Grafton, Ill	1,306	23	14.5	2, 3	12.5	21, 22	13.3	2.0
St. Louis, Mo	1,264	30	18.9	2	13.3	22	15.5	5.6
Chester, Ill	1,189	30	16.3	3	11.7	23	13.6	4.6
Cape Girardeau, Mo.	1,128	28	21.1	4	16.7	23, 24	18.5	4.4
New Madrid, Mo.	1,003	34	27.8	2, 3	17.2	26	21.0	10.6
Luxora, Ark	905	33	21.4	4	10.9	27, 28	14.9	10.5
Memphis, Tenn	843	33	25.9	5	14.0	27-29	18.7	11.9
Helena, Ark.	767	42	34.4	6, 7	20.8	29, 30	27.0	13.6
Arkansas City, Ark.	635	42	38.9	9	27.4	30	33.7	11.5
Greenville, Miss.	595	42	33.1	9, 10	22.5	30	28.4	10.6
Vicksburg, Miss.	474	45	37.3	11, 12	26.9	30	33.4	10.4
Natchez, Miss.	378	46	38.3	12, 13	30.5	30	35.5	7.8
Baton Rouge, La	240	35	28.6	13-15	24.2	29	27.2	4.4
Donaldsonville, La	188	28	22.5	14	18.9	29, 30	21.2	3.6
New Orleans, La.	108	16	14.4	17	12.4	29, 30	13.6	2.0
Atchafalaya River.								
Simmesport, La.	127	......	34.0	14-16	29.8	30	32.6	4.2
Melville, La.	103	31	32.8	12-16	30.5	29, 30	32.0	2.3
Morgan City, La	19	8	4.7	4, 21, 25	3.2	16	3.9	1.5
Grand River.								
Grand Rapids, Mich	38	11	7.6	1	1.8	20	3.7	5.8
Penobscot River.								
Mattawamkeag, Me. (2)	87	......	15.5	3	12.7	30	14.2	2.8
West Enfield, Me	60	......	12.7	2	7.0	30	9.3	5.7
Kennebec River.								
Winslow, Me	46	......	7.6	1	2.7	10	4.8	4.9
Merrimac River.								
Franklin Junction, N. H.	110	......	11.5	1	5.1	19, 20	6.5	6.4
Concord, N. H.	94	......	7.0	1	1.9	21	3.1	5.1
Manchester, N. H.	68	......	5.7	1	2.0	10, 19	3.0	3.7
Connecticut River.								
Wells River, Vt.	255	......	31.4	1	23.5	29	25.9	7.9
Whiteriver Junction, Vt.	209	......	18.0	1	8.1	21	11.0	9.9
Bellows Falls, Vt.	170	12	10.1	1	2.6	21	4.5	7.5
Holyoke, Mass	84	9	10.5	1	2.7	21	4.5	7.8
Hartford, Conn.	50	13	24.0	2	6.9	30	12.5	17.1
Housatonic River.								
Gaylordsville, Conn.	44	15	8.4	1	4.8	30	6.1	3.6

TABLE VI.—*Heights of rivers referred to zeros of gages*—Continued.

Stations.	Distance to mouth of river.	Danger line on gage.	Highest water. Height.	Highest water. Date.	Lowest water. Height.	Lowest water. Date.	Mean stage.	Monthly range.
	Miles.	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Mohawk River.								
Tribeshill, N. Y.	42	15	8.0	1,2	2.0	19–21, 27–29	3.8	6.0
Schenectady, N. Y.	19	15	11.4	1	2.3	29	4.9	9.1
Hudson River.								
Troy, N. Y.	154	14	18.2	3	5.0	28	11.4	13.2
Albany, N. Y.	147	12	14.2	1	4.3	28, 30	7.5	9.9
Pompton River.								
Pompton Plains, N. J.	6	8	5.0	7	4.6	14–30	4.7	0.4
Passaic River.								
Chatham, N. J.	69	7	4.0	6	2.5	21, 28–30	3.0	1.5
Lehigh River.								
Mauchchunk, Pa	45	15	5.1	1	4.2	15–17	4.6	0.9
Schuylkill River.								
Reading, Pa	66	12	1.6	6	0.2	24	0.8	1.4
Delaware River.								
Hancock (E. Branch), N. Y.	269	12	7.1	1	3.6	29	4.6	3.5
Hancock (W. Branch), N. Y.	269	10	5.9	1	3.6	29, 30	4.5	2.3
Port Jervis, N. Y	204	14	6.0	1	1.8	29, 30	2.7	4.7
Phillipsburg, N. J.	142	26	9.0	1	2.6	29	4.6	6.4
Trenton, N. J.	92	18	6.4	1	2.2	30	3.4	4.2
North Branch Susquehanna.								
Binghamton, N. Y	183	16	9.4	1	2.9	29, 30	5.1	6.5
Towanda, Pa.	139	16	8.6	1	2.4	30	4.5	6.2
Wilkesbarre, Pa	60	17	15.2	1	5.7	30	9.0	9.5
West Branch Susquehanna.								
Clearfield, Pa.	165	8	3.4	12	1.5	4–7	2.0	1.9
Lockhaven, Pa.	65	12	– 2.0	1–30	– 2.0	1–30	–2.0	0.0
Williamsport, Pa.	39	20	6.3	1	3.3	21	4.4	3.0
Juniata River.								
Huntingdon, Pa.	90	24	4.9	11, 12	3.7	29, 30	4.1	1.2
Susquehanna River.								
Selinsgrove, Pa.	116	17	7.2	1	2.4	22	3.8	4.8
Harrisburg, Pa.	69	17	8.4	1	3.2	30	4.8	5.2
Shenandoah River.								
Riverton, Va.	58	22	0.5	1–30	0.5	1–30	0.5	0.0
Potomac River.								
Cumberland, Md.	290	8	3.7	1	2.9	30	3.2	0.8
Harpers Ferry, W. Va.	172	18	5.0	1	0.6	29, 30	2.3	4.4
James River.								
Buchanan, Va.	305	12	4.3	7	2.5	23–30	3.0	1.8
Lynchburg, Va.	260	18	1.9	11	0.8	26–30	1.3	1.1
Columbia, Va.	167	18	5.0	6, 13	1.6	30	3.0	3.4
Richmond, Va.	111	12	1.7	13	0.2	29	0.6	1.5
Dan River.								
Danville, Va.	55	8	2.9	15	0.0	3, 4, 23–26	0.7	2.9
Roanoke River.								
Clarksville, Va	196	12	5.0	16	0.3	4, 5	1.7	4.7
Weldon, N. C.	129	30	23.2	16, 17	9.8	4, 5	13.2	13.4
Tar River.								
Tarboro, N. C.	46	25	15.8	18	5.1	5	8.9	10.7
Greenville, N. C.	21	22	.....	.....	.....	.....	.....	.....
Cape Fear River.								
Moncure, N. C.	171	25	12.9	16	1.7	3, 26	5.0	11.2
Fayetteville, N. C	112	38	25.3	15	5.1	3	12.7	20.2
Waccamaw River.								
Conway, S. C.	40	7	4.8	1	3.2	12	3.9	1.6
Pedee River.								
Cheraw, S. C	149	27	17.1	14	2.3	5	5.8	14.8
Smiths Mills, S. C.	51	16	11.7	22	5.8	7, 8	9.0	5.9
Lynch Creek.								
Effingham, S. C.	35	12	8.8	29, 30	5.0	3–6	6.5	3.8
Black River.								
Kingstree, S. C.	45	12	7.7	4	5.0	8, 10–13	6.0	2.7
Catawba River.								
Mount Holly, N. C	28	15	2.2	14–18	1.6	1–4	1.9	0.6
Wateree River.								
Camden, S. C.	37	24	9.4	14	5.4	26	6.6	4.0
Congaree River.								
Columbia, S. C	52	15	2.3	13, 14	0.5	27	1.2	1.8
Santee River.								
St. Stephens, S. C.	50	12	6.8	17	2.6	7	4.3	4.2
Edisto River.								
Edisto, S. C.	75	6	3.5	17	2.7	12, 21–24	3.0	0.8
Broad River.								
Carlton, Ga.	30	11	2.3	6	2.0	19–29	2.1	0.3
Savannah River.								
Calhoun Falls, S. C.	347	15	2.9	13	2.1	3, 26, 27	2.3	0.8
Augusta, Ga.	268	32	8.6	16	6.6	27	7.6	2.0
Oconee River.								
Milledgeville, Ga.	147	25	5.9	13	2.3	25, 29	3.0	3.6
Dublin, Ga	79	30	5.3	15	1.0	30	2.2	4.3
Ocmulgee River.								
Macon, Ga.	203	18	6.3	13	2.0	26–29	2.9	4.3
Abbeville, Ga.	96	11	8.4	17	4.3	27–30	5.5	4.1
Flint River.								
Woodbury, Ga.	227	10	1.2	6	0.4	26–28	0.7	0.8
Montezuma, Ga.	152	20	8.5	15	3.7	26, 30	4.7	4.8
Albany, Ga.	90	20	10.6	15	4.0	7	5.6	6.6
Bainbridge, Ga	29	22	12.4	17	7.5	9	9.0	4.9
Oakdale, Ga.	305	18	.....	.....	.....	.....	.....	.....
Chattahoochee River.								
West Point, Ga	239	20	3.3	10	2.0	28, 29	2.7	1.3
Eufaula, Ala	90	40	9.0	14	2.2	4	4.2	6.8
Alaga, Ala	30	25	12.8	14	4.7	28	6.4	8.1
Coosa River.								
Rome, Ga.	271	30	4.3	30	1.8	27	2.5	2.5
Gadsden, Ala.	144	22	4.0	10	1.9	25–27	2.6	2.1
Lock No. 4, Ala.	116	17	3.4	11	2.1	26, 27	2.6	1.3
Wetumpka, Ala	6	45	10.0	9	5.6	26, 27	7.2	4.4
Tallapoosa River.								
Milstead, Ala.	38	35	5.0	14	2.5	27	3.2	2.5
Alabama River.								
Montgomery, Ala.	265	35	6.8	10	3.0	26, 27	4.3	3.8
Selma, Ala	212	35	8.5	11	4.8	27–29	6.4	3.7
Black Warrior River.								
Tuscaloosa, Ala.	90	43	15.5	9	7.6	21	9.6	7.9
Tombigbee River.								
Columbus, Miss	303	33	6.8	30	2.9	10	3.7	4.9
Vienna, Ala.	233	42	10.2	13	3.8	3, 4	6.9	6.4
Demopolis, Ala.	155	35	19.2	27	7.2	5	12.6	12.0
Leaf River.								
Hattiesburg, Miss	60	20	15.1	27	4.8	3	8.2	10.3
Chickasawhay River.								
Enterprise, Miss	144	18	14.2	26	3.6	2, 3	6.7	10.6
Shubuta, Miss.	106	25	24.1	26	3.6	5	10.1	20.5
Pascagoula River.								
Merrill, Miss.	78	20	18.7	30	7.7	24	12.1	11.0
Pearl River.								
Jackson, Miss	242	20	17.9	30	10.5	3	13.8	7.4
Columbia, Miss	110	14	19.1	28	10.5	24	13.4	8.6
Sabine River.								
Logansport, La.	315	25	26.0	30	20.8	2, 14	23.2	5.2
Neches River.								
Rockland, Tex	105	20	20.3	7	8.7	23	14.2	11.6
Beaumont, Tex	18	10	5.6	12	3.3	29	4.4	2.3
Trinity River.								
Dallas, Tex.	320	25	32.0	26	4.9	18	15.7	27.1
Long Lake, Tex	211	35	34.1	30	17.1	22	28.6	17.0
Riverside, Tex.	112	40	32.9	30	9.7	24	20.6	23.2
Liberty, Tex	20	25	24.6	7	18.3	25	21.8	6.3
Brazos River.								
Kopperl, Tex.	345	21	17.0	27	0.8	1, 21–23	3.2	16.2
Waco, Tex.	285	24	15.6	30	4.0	22, 23	7.5	11.6
Valley Junction, Tex.	.....	.....	24.0	30	2.2	25	7.4	21.8
Hempstead, Tex	140	40	32.8	30	2.0	23	13.6	30.8
Booth, Tex	61	39	28.0	30	5.2	22	14.4	22.8
Colorado River.								
Ballinger, Tex.	489	21	12.5	25	1.6	19–22	3.4	10.9
Austin, Tex.	214	18	16.5	30	1.7	23	.....	14.8
Columbus, Tex.	98	24	25.4	25	7.7	23	12.8	17.7
Guadalupe River.								
Gonzales, Tex	112	22	24.0	26	1.2	1–3	4.7	22.8
Victoria, Tex	35	16	22.1	30	2.9	3	8.0	19.2
Red River of the North.								
Moorhead, Minn.	284	26	9.1	1	7.8	30	8.2	1.3
Kootenai River.								
Bonners Ferry, Idaho.	123	24	7.9	28	0.4	1–5	2.0	7.5
Pend d'Oreille River.								
Newport, Wash.	86	14	1.4	30	– 0.1	4–10	0.3	1.5
Snake River.								
Lewiston, Idaho	144	24	6.5	27	3.8	4–6	4.7	2.7
Columbia River.								
Wenatchee, Wash	473	40	11.5	28	6.6	2–4	7.9	4.9
Umatilla, Oreg.	270	25	8.0	28	4.0	6, 7	5.2	4.0
The Dalles, Oreg.	166	40	11.5	29, 30	5.6	10	7.0	5.9
Willamette River.								
Eugene, Oreg.	183	10	6.0	2, 3	3.2	30	4.3	2.8
Albany, Oreg.	118	20	7.4	1	2.8	30	4.5	4.6
Salem, Oreg	84	20	6.8	1	2.1	30	4.1	4.7
Portland, Oreg.	12	15	6.8	1	3.9	12, 13	5.3	2.9
Sacramento River.								
Red Bluff, Cal.	201	23	10.6	1	3.8	28	5.9	6.8
Sacramento, Cal.	64	25	21.7	1, 2	19.6	24, 25	20.6	2.1

Small figures indicate number of days river was frozen. (*) 1 day missing.

Honolulu, Hawaii, latitude, 21° 19′ north, longitude 157° 52′ west; barometer above sea, 38 feet; gravity correction, —.057 applied. April, 1905.

Day.	Pressure.*		Air temperature.				Moisture.				Wind.				Precipitation.		Clouds.					
							8 a. m.		8 p. m.		8 a. m.		8 p. m.				8 a. m.			8 p. m.		
	8 a. m.	8 p. m.	8 a. m.	8 p. m.	Maximum.	Minimum.	Wet.	Relative humidity.	Wet.	Relative humidity.	Direction.	Velocity.	Direction.	Velocity.	8 a. m.	8 p. m.	Amount.	Kind.	Direction.	Amount.	Kind.	Direction.
1	30.04	30.02	74.2	71.7	79	67	64.2	58	65.8	73	e.	8	ne.	13	T.	0.00	2	Cu.	e.	1	S.-cu.	e.
2	30.07	30.10	74.1	70.0	78	67	65.5	63	65.0	77	ne.	9	ne.	12	0.00	T.	1 2	Ci. S.-cu.	w. e.	9	N.	0
3	30.12	30.12	70.2	68.0	74	65	65.7	79	60.1	63	ne.	21	ne.	18	0.20	T.	3 4	Ci. N.	nw. ne.	1	S.-cu.	ne.
4	30.13	30.10	70.0	68.2	76	64	61.0	59	60.0	61	ne.	16	ne.	15	T.	0.00	1 3	Ci.-s. S.-cu.	0 ne.	2	S.-cu.	0
5	30.14	30.11	68.8	65.4	75	63	61.8	67	62.3	84	e.	8	ne.	8	T.	0.08	6	N.	e.	10	N.	0
6	30.11	30.09	68.5	67.0	74	64	63.0	74	63.0	80	ne.	12	ne.	12	0.12	0.05	9	N.	ne.	9	N.	0
7	30.09	30.06	70.4	69.1	75	66	62.4	64	62.0	67	ne.	16	ne.	9	0.07	0.00	1	Cu.	ne.	1	S.-cu.	ne.
8	30.08	30.06	72.5	70.1	77	65	63.0	59	61.2	60	ne.	7	ne.	15	0.00	0.00	few.	Cu.	ne.	few.	S.-cu.	0
9	30.14	30.14	71.0	70.5	76	67	62.5	62	62.0	62	ne.	10	ne.	16	0.00	T.	8	S.-cu.	ne.	7	S.-cu.	ne.
10	30.16	30.14	70.5	69.1	74	67	62.0	62	60.1	59	e.	10	ne.	9	T.	T.	9	S.-cu.	e.	1	Cu.	e.
11	30.08	30.06	71.1	70.5	76	64	61.1	56	63.0	66	e.	11	n.	5	0.00	0.00	1	S.-cu.	e.	1 3	Ci. S.-cu.	0 ne.
12	30.07	30.03	70.5	70.2	75	62	63.0	66	64.0	71	nw.	5	ne.	8	0.00	0.00	1 1	Ci.-cu. Cu.	0 0	6	S.-cu.	ne.
13	30.07	30.04	68.5	68.0	75	63	62.0	70	63.1	76	ne.	6	ne.	16	0.00	0.01	1 7	Ci.-cu. S.-cu.	0 ne.	1	S.-cu.	ne.
14	30.09	30.07	72.3	70.0	76	66	64.0	64	64.4	74	ne.	8	e.	6	0.00	0.00	4 1	Ci.-s. Cu.	0 ne.	5 1	A.-cu. S.-cu.	w. ne.
15	30.06	30.06	71.4	68.0	76	64	66.4	77	65.0	85	ne.	2	n.	3	T.	0.57	2 6	Cu. S.-cu.	ne. 0	10	S.-cu.	e.
16	30.09	30.06	73.3	71.4	76	69	65.9	67	64.4	68	n.	9	ne.	13	0.01	T.	1 5	S.-cu. N.	e. e.	1	Cu.	e.
17	30.07	30.05	74.5	73.0	80	68	68.0	72	67.0	73	e.	8	n.	2	0.01	0.00	7	S.-cu.	e.	1	S.-cu.	e.
18	30.07	30.05	76.0	72.4	81	68	67.6	64	65.1	68	e.	6	ne.	4	0.00	0.00	7 1	Ci.-s. Cu.	w. e.	1	S.-cu.	e.
19	30.10	30.09	75.4	72.8	80	68	66.4	62	65.3	67	e.	5	ne.	4	0.00	0.00	3	Cu.	e.	few.	S.-cu.	e.
20	30.13	30.08	75.8	73.4	80	68	66.3	61	66.4	69	ne.	8	ne.	4	0.01	T.	5	S.-cu.	e.	9	N.	e.
21	30.07	30.05	73.0	72.3	79	68	67.0	73	65.8	71	e.	8	n.	9	0.01	T.	10	S.-cu.	e.	few.	S.-cu.	e.
22	30.06	30.08	74.1	71.8	80	68	65.0	61	63.3	63	ne.	5	ne.	10	0.00	T.	3	Cu.	ne.	few.	S.-cu.	ne.
23	30.14	30.18	74.5	72.5	78	69	63.5	54	64.0	63	e.	8	ne.	14	0.00	0.00	1	Cu.	e.	4	S.-cu.	e.
24	30.22	30.24	68.5	70.3	74	66	65.8	87	63.3	68	ne.	13	ne.	11	0.23	0.05	10	N.	ne.	10	N.	0
25	30.23	30.17	72.5	72.0	76	69	66.0	71	64.0	65	n.	3	ne.	6	0.01	T.	7	S.-cu.	ne.	10	S.-cu.	e.
26	30.17	30.13	72.1	71.0	78	67	64.4	66	65.0	73	ne.	12	ne.	4	T.	T.	8	S.-cu.	e.	6	S.-cu.	e.
27	30.12	30.12	70.3	72.1	77	66	66.3	81	65.1	69	n.	2	ne.	10	0.02	T.	1 8	S.-cu. N.	e. e.	3	S.-cu.	e.
28	30.14	30.11	70.2	72.2	76	67	67.2	86	66.0	72	ne.	8	e.	16	T.	0.03	1 8	S.-cu. N.	e. e.	8	S.-cu.	e.
29	30.15	30.15	73.4	73.0	78	70	64.9	63	64.0	61	ne.	11	ne	8	T.	0.01	2 4	Cu. S.-cu.	e. e.	8	S.-cu.	e.
30	30.15	30.12	67.1	71.1	72	64	65.0	89	64.0	68	ne.	17	ne.	13	0.38	0.22	2 6	S.-cu. N.	e. e.	9	N.	e.
31	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Mean....	30.112	30.096	71.8	70.6	76.7	66.3	64.6	67.9	63.8	69.2	ne.	9.1	ne.	9.8	1.07	1.02	5.8	S.-cu.	e.	4.6	S.-cu.	e.

Observations are made at 8 a. m. and 8 p. m., local standard time, which is that of 157° 30′ west, and is 5h and 30m slower than 75th meridian time. * Pressure values are reduced to sea level and standard gravity.

COSTA RICAN CLIMATOLOGICAL DATA.

Communicated by Mr. H. PITTIER, Director, Physico-Geographic Institute.

TABLE 1.—*Hourly observations at the Observatory, San José de Costa Rica, during April, 1905.*

Hours.	Pressure.	Temperature.	Relative humidity.	Rainfall. Amount.	Rainfall. Duration.	Sunshine.	Cloudiness.	Temperature of the soil at depth of— 6 inches.	12 inches.	24 inches.	48 inches.
	Inches.	° F.	%	Ins.	Hrs.	Hrs.	%	° F.	° F.	° F.	° F.
1 a. m.	26.15	64.4	88								
2 a. m.	26.13	63.7	90								
3 a. m.	26.12	62.6	89								
4 a. m.	26.11	61.7	91								
5 a. m.	26.11	61.5	92								
6 a. m.	26.13	61.7	90								
7 a. m.	26.13	62.6	84			16.64	46	74.7	74.8	74.8	72.3
8 a. m.	26.15	67.5	72			23.83					
9 a. m.	26.16	72.3	62			25.43					
10 a. m.	26.16	77.5	54			25.94	41	74.8	74.7	74.8	72.3
11 a. m.	26.15	79.3	51			23.94					
Noon	26.14	81.3	49			24.41					
1 p. m.	26.12	82.9	49	0.02	0.25	24.26	52	76.3	75.2	74.8	72.3
2 p. m.	26.10	81.5	52	0.02	0.05	23.01					
3 p. m.	26.08	78.8	56			19.32					
4 p. m.	26.08	77.2	62	0.27	1.01	14.99	78	77.2	75.7	74.8	72.3
5 p. m.	26.08	72.1	72	0.31	1.58	10.47					
6 p. m.	26.09	70.5	78	0.12	1.08	3.51					
7 p. m.	26.11	69.3	80	0.02	0.08		69	76.8	75.9	75.0	72.3
8 p. m.	26.12	68.0	82	0.02	0.17						
9 p. m.	26.14	67.1	83								
10 p. m.	26.15	66.6	83				63		75.7	75.0	72.3
11 p. m.	26.16	65.7	85								
Midnight	26.16	65.1	87	0.02	0.17						
Mean	26.13	70.0	74				58	76.6	75.6	74.8	71.2
Min	26.01	55.8	31								
Max	26.22	93.6	100								
Total				0.80	4.39	235.75					

REMARKS.—At San José the barometer is 3835 feet above sea level. Readings are corrected for gravity, temperature, and instrumental error. The hourly readings for pressure, and wet and dry bulb thermometers, are obtained by means of Richard registering instruments, checked by direct observations every three hours from 7 a. m. to 10 p. m. The thermometers are 5 feet above ground and are corrected for instrumental errors. The total hourly rainfall is as given by Hottinger's self-register, checked once a day. The standard rain gage is 5 feet above ground. Since January 1, 1902, observations at San José have been made on seventy-fifth meridian time, which is 0 hours, 36 minutes, 13.3 seconds *in advance* of San José local time.

TABLE 2.—*Rainfall at stations in Costa Rica, April, 1905.*

Stations.	Rainfall. Amount.	Rainfall. Number of days.	Stations.	Rainfall. Amount.	Rainfall. Number of days.
	Inches.			Inches.	
Sipurio (Calamanca)	5.87	10	Peralta	0.59	13
Bearesem	13.11	9	Juan Vinas	1.10	3
Limon	16.93	18	Paraiso	1.34	6
Swamp Mouth	1.38	15	Las Concavas	1.54	12
Zent	10.87	15	Tres Rios	0.20	6
Victoria	10.20	20	San Jose	0.80	7
La Luisiana	14.09	13	La Verbana	1.34	11
Iroquois	17.52	17	Nuestro Amo	2.36	8
San Carlos	3.70	10	Puntarenas	0.35	2
Las Lomas	0.87	10	Las Canas	1.10	1

Notes on earthquakes.—April 3, 5^h 29^m a. m., shock NE.-SW., intensity II, duration 9 seconds; 1^h 3^m p. m., slight shock NE.-SW., intensity I, duration 3 seconds. April 1, 1^h 54^m p. m., slight shock SE.-NW., intensity I, duration 2 seconds. April 12, 5^h 2^m a. m., shock NE.-SW., intensity II, duration 3 seconds. April 16, very slight shock, indeterminate elements. April 17, 11^h 21^m a. m., shock NW.-SE., intensity 2, duration 4 seconds. April 21, 2^h 27^m a. m., light shock NE.-SW., intensity I, duration 2 seconds. April 24, 11^h 22^m p. m., NW.-SE., intensity II, duration 3 seconds. April 26, 2^h a. m., slight shock, N.-S., intensity I, duration 2 seconds; 0^h 2^m p. m., NW.-SE., intensity I, duration 3 seconds. April 29, 4^h 17^m a. m., NE.-SW., intensity I, duration 2 seconds; 6^h 10^m p. m., intensity I, duration 3 seconds.

Chart I. Tracks of Centers of High Areas, April, 1905.

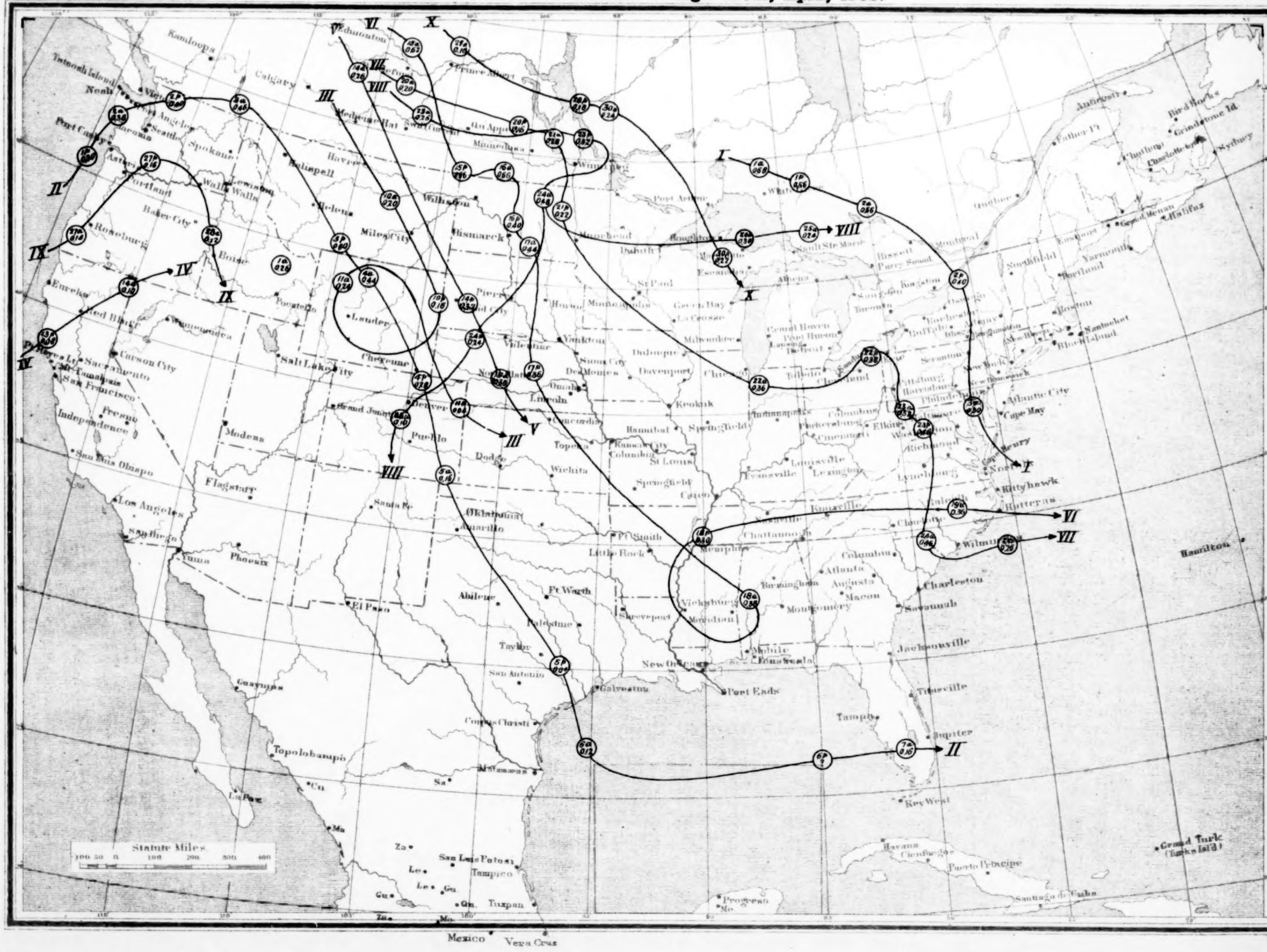


Chart II. Tracks of Centers of Low Areas, April, 1905.

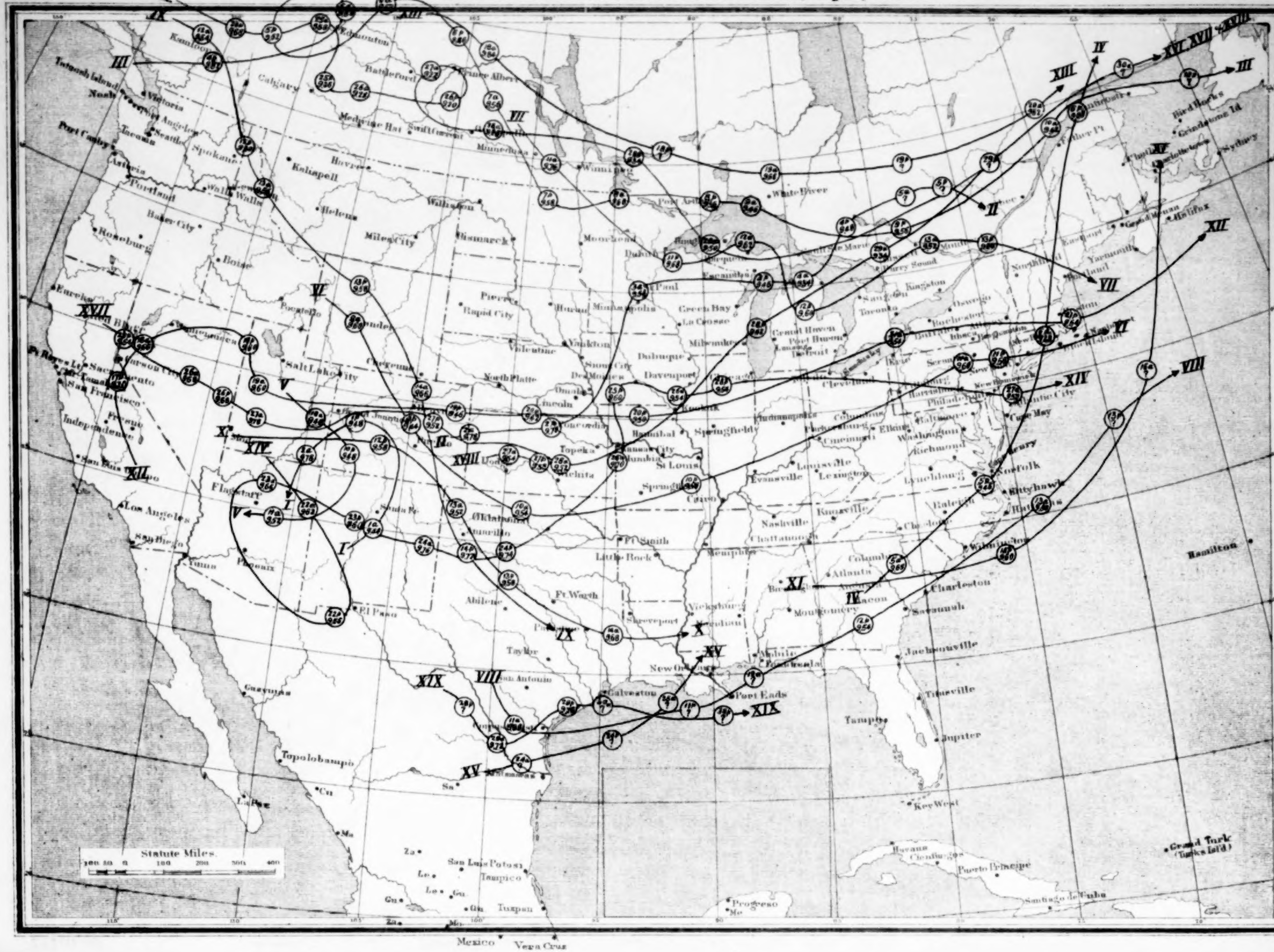


Chart III. Total Precipitation, April, 1905.

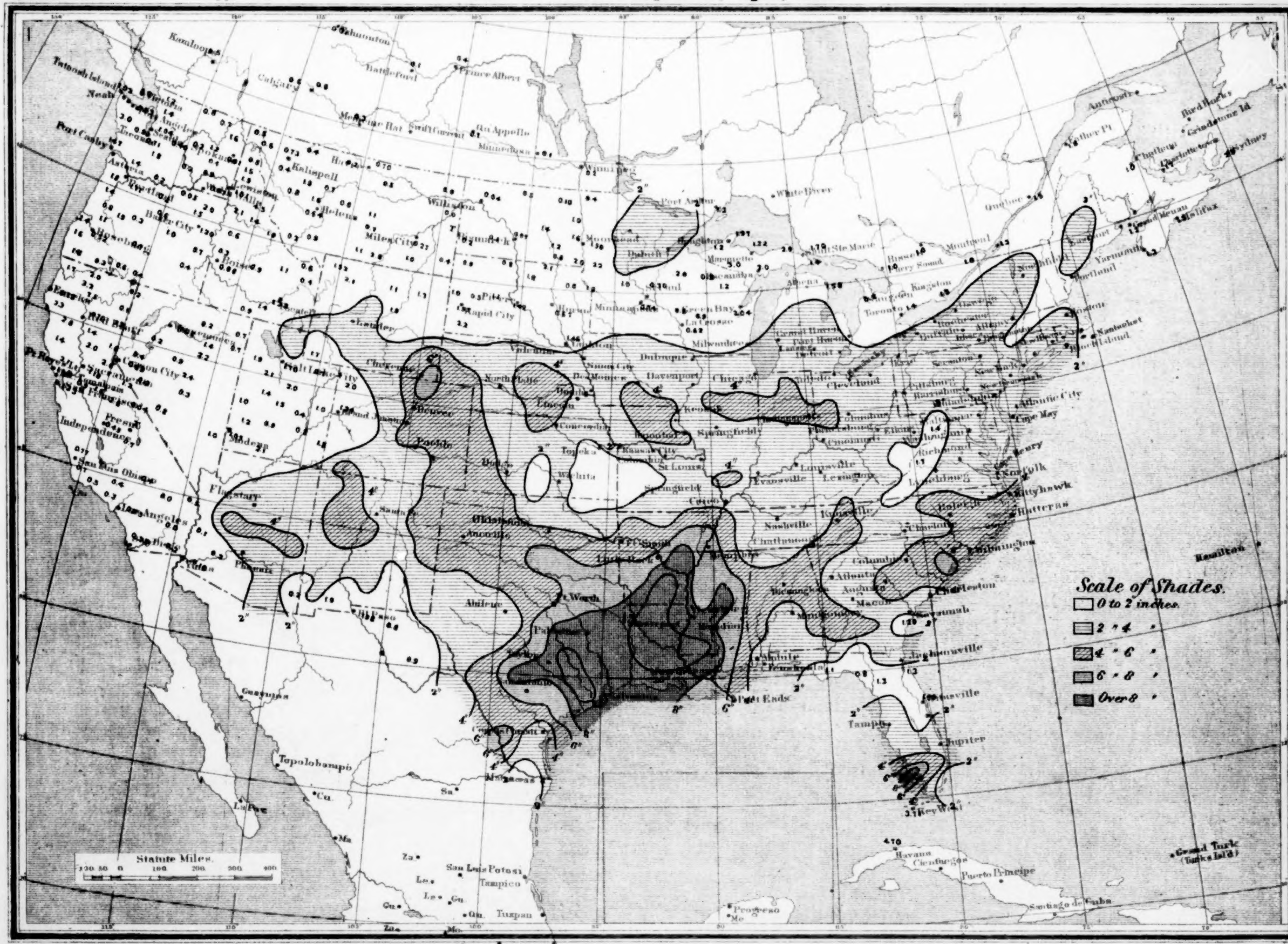


Chart IV. Percentage of Clear Sky, April, 1905.

Chart V. Hydrographs for Seven Principal Rivers of the United States, April, 1905.

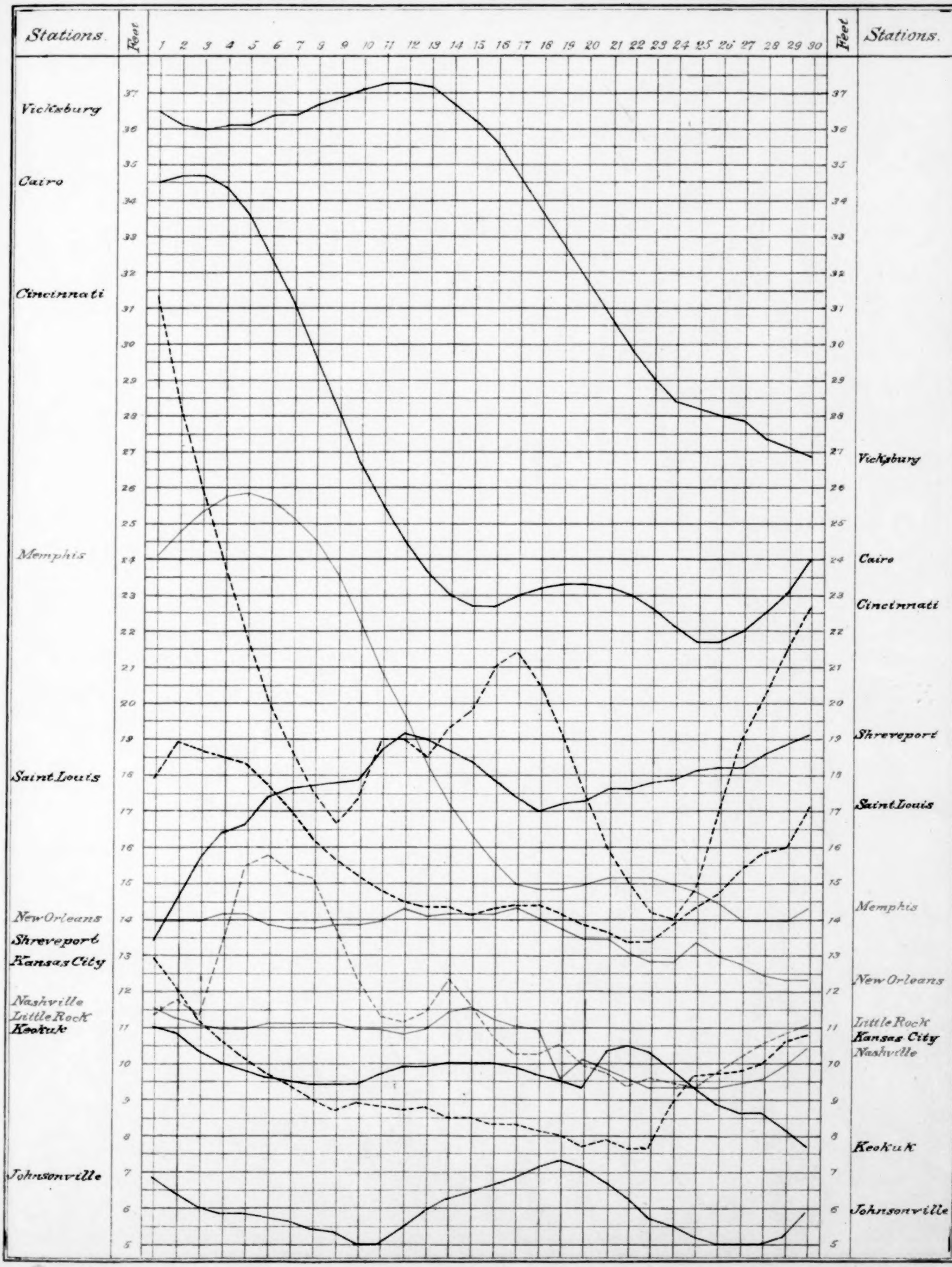


Chart VI. Isobars and Isotherms at 10,000 feet, April, 1905.

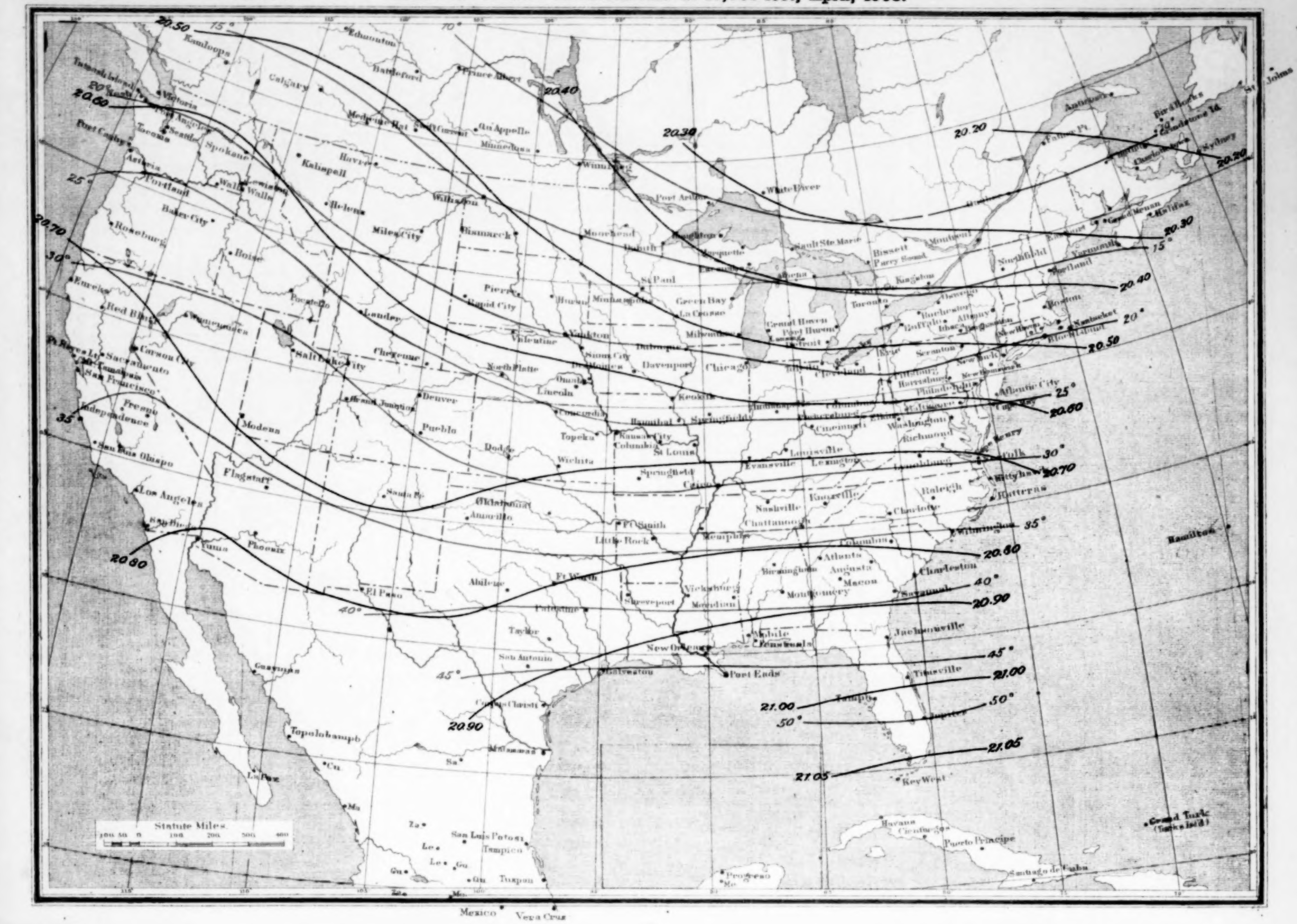


Chart VII. Isobars and Isotherms at 3500 feet, April, 1905.

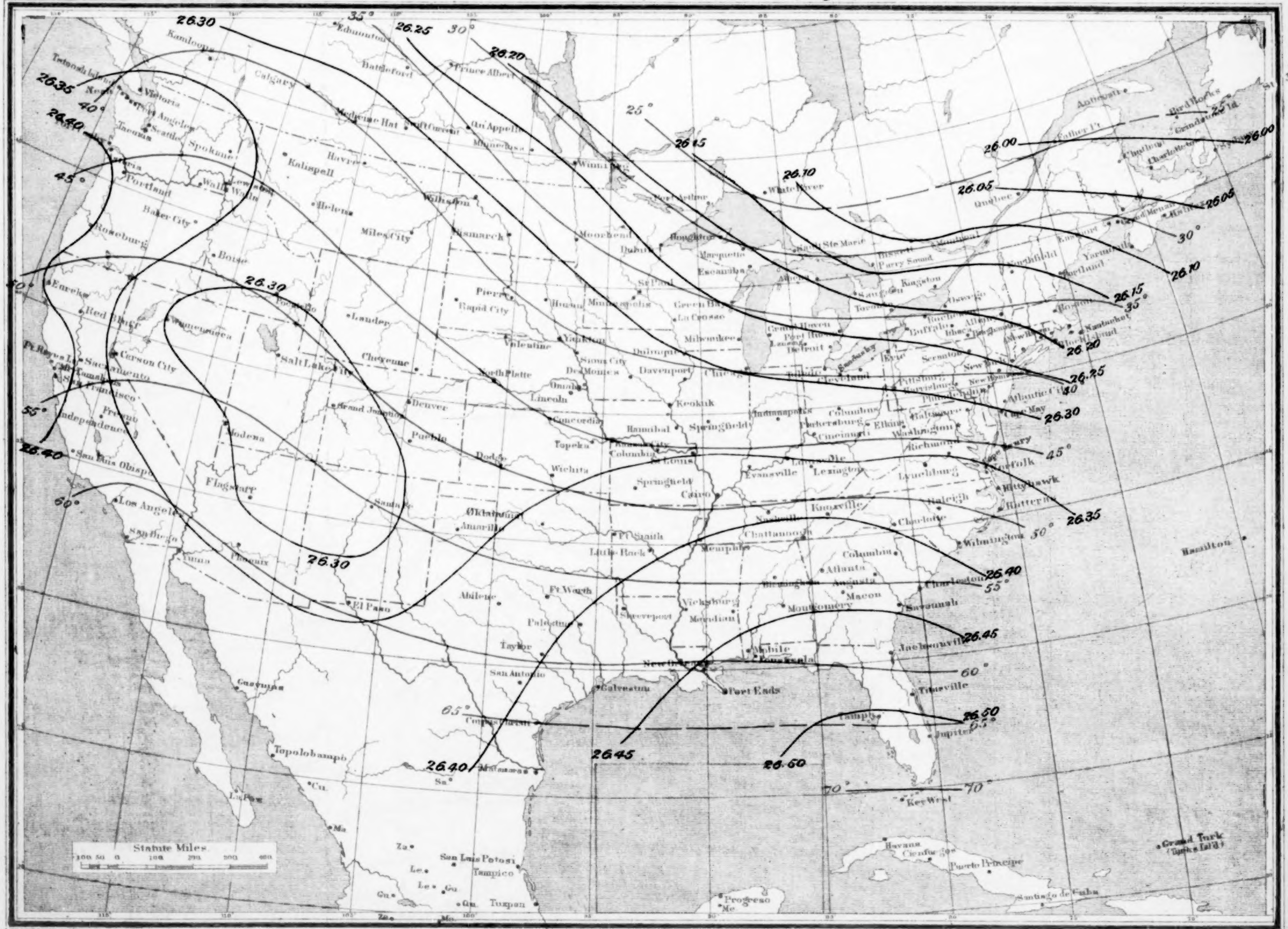


Chart VIII. Isobars and Isotherms at Sea Level; Resultant Surface Winds, April, 1905.

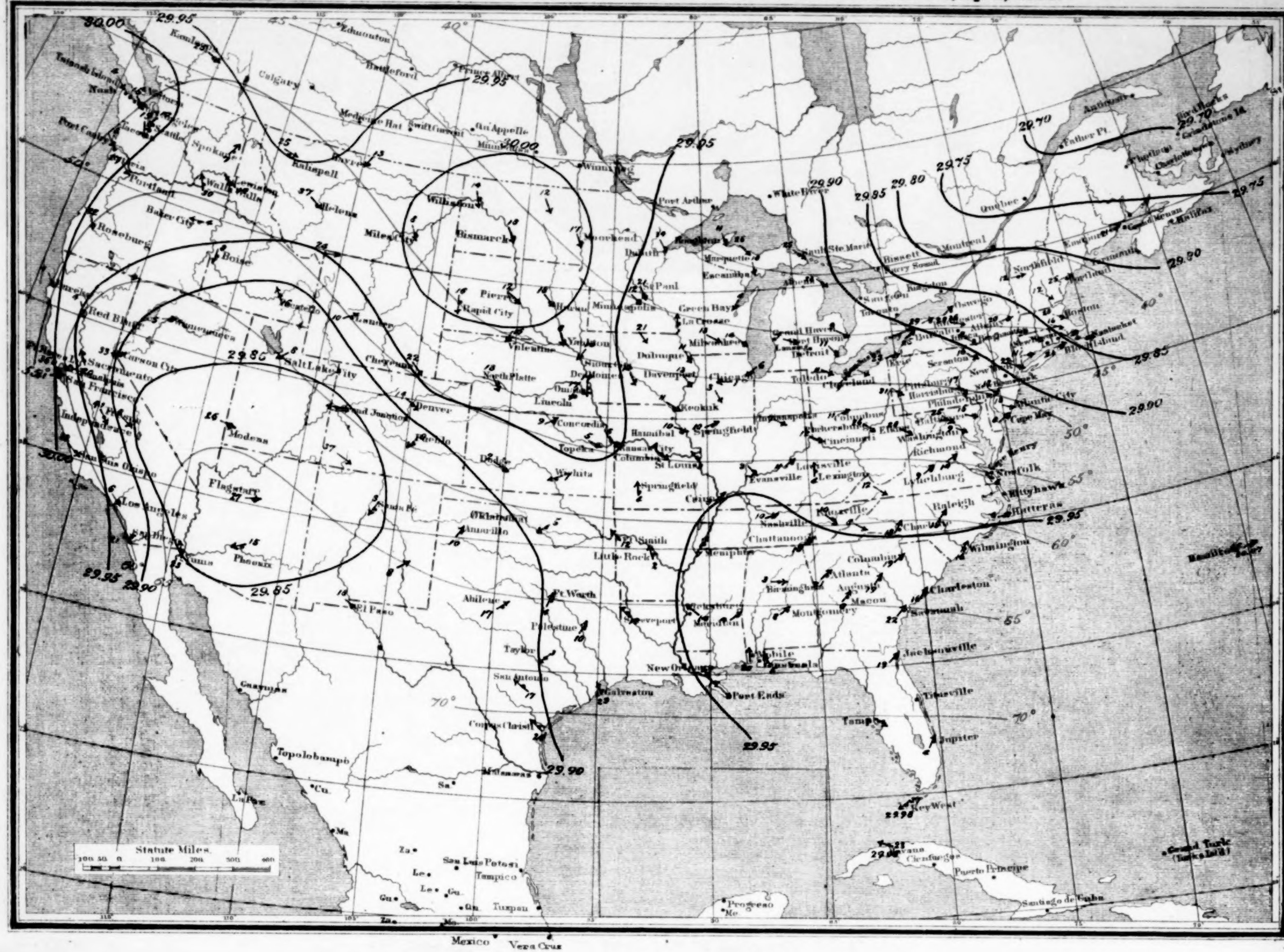


Chart IX. Sea-Level Isobars, Surface Temperatures, and Resultant Winds, April, 1905.

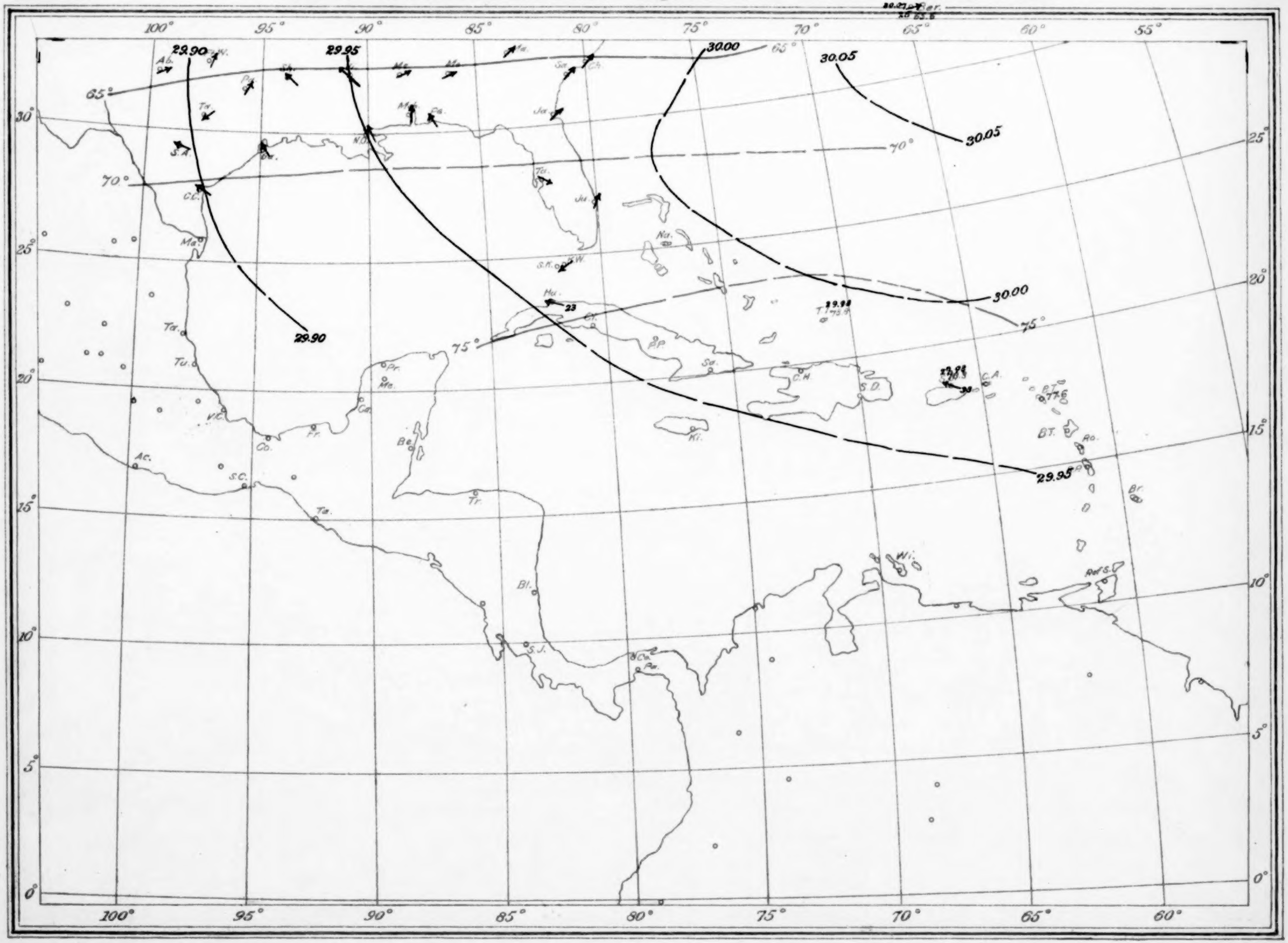


Chart X. Total Snowfall for April, 1905.

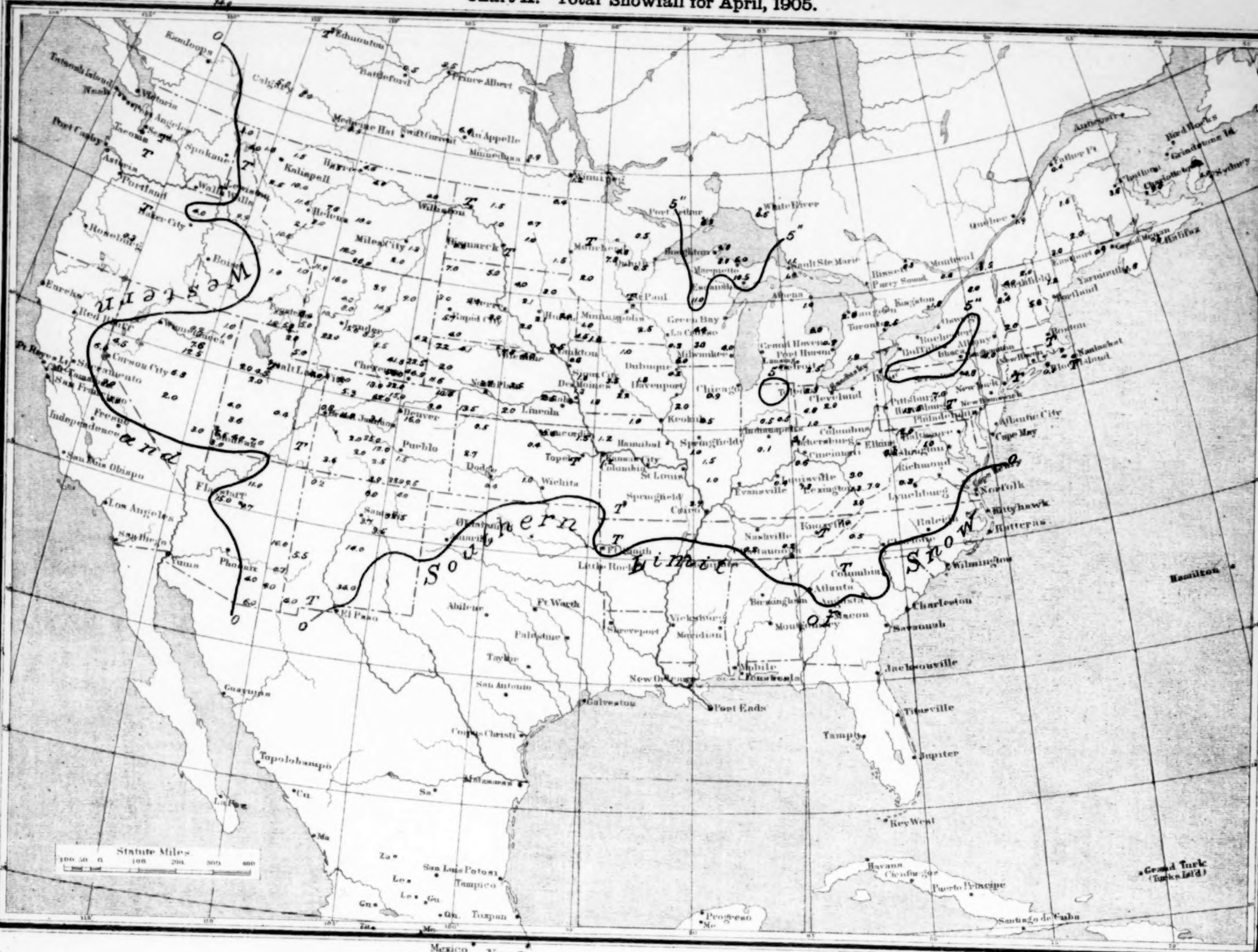


Chart XI. Diurnal Variation of the Atmospheric Electric Potential at Perpignan, Paris, and Greenwich.

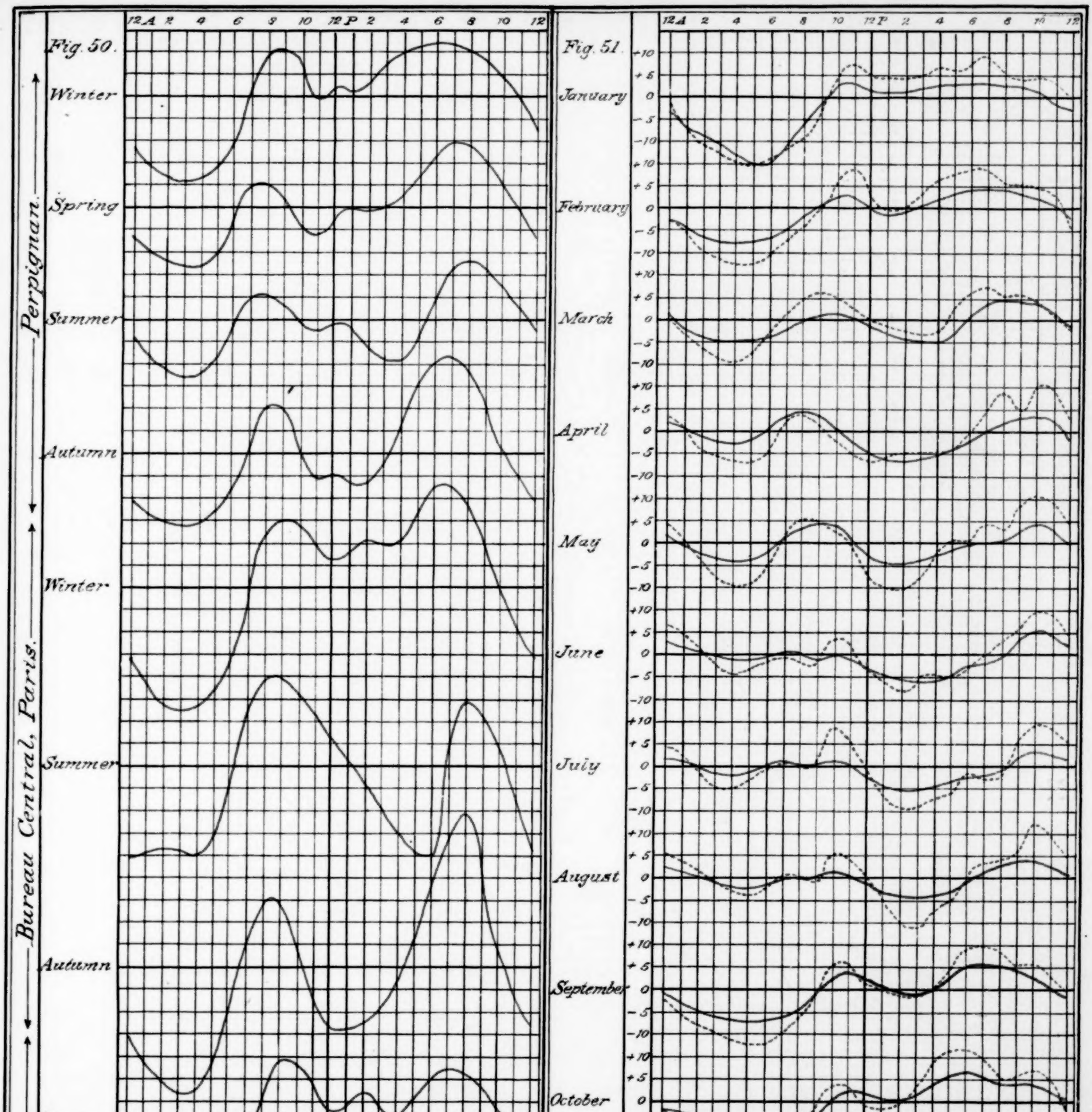


Chart XII. Diurnal Variation of the Vapor Tension at Parc St. Maur, Paris, and Blue Hill.

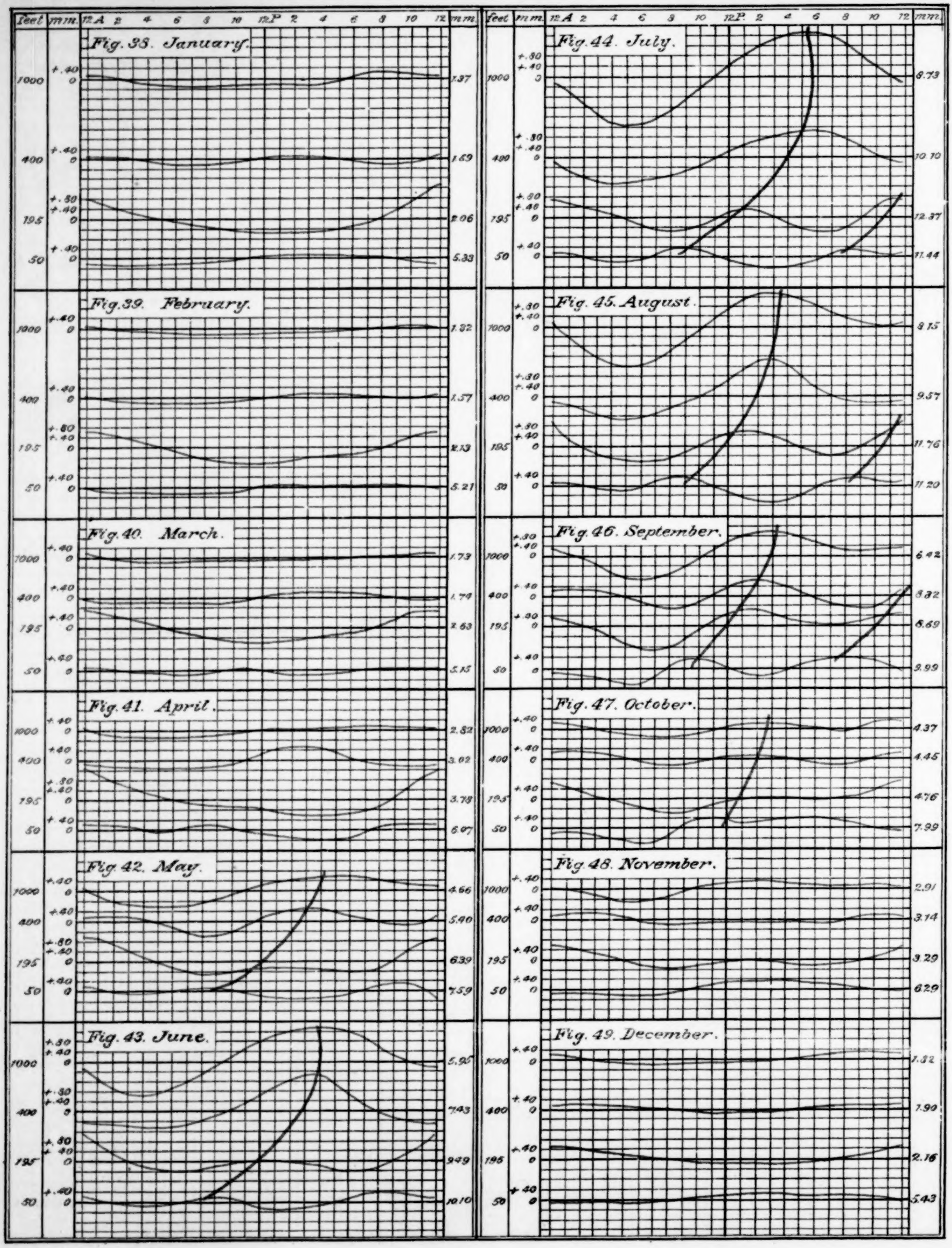


Chart XIII. The Relation of the Diurnal Variation of Atmospheric Electricity to the Other Meteorological Elements.

FIG. 52.—Coefficient of electric dissipation.

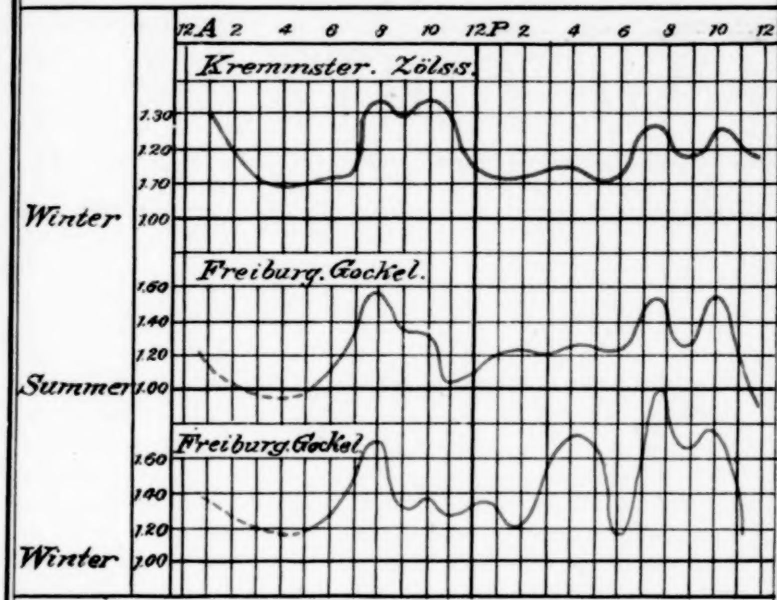
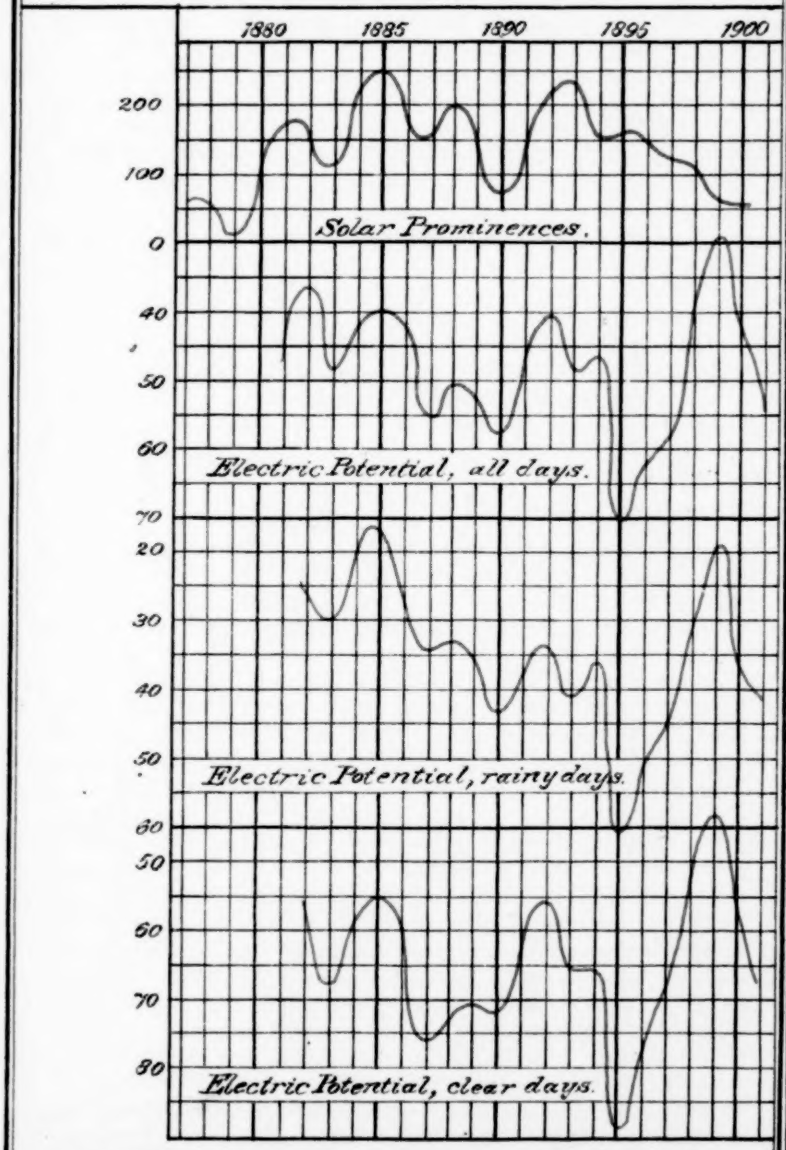


FIG. 53.—Annual variation of the number of the solar prominences and the atmospheric electric potential.



The atmospheric electric potential seems to be inverted relatively to the solar prominence frequency, and hence to solar activity; an increase of solar activity makes a decrease in atmospheric electricity gradient.

FIG. 54.—Comparison of the diurnal periods of the temperature-fall, pressure, temperature, vapor tension, electric potential, and coefficient of dissipation.